DOCUMENT RESUME

ED 034 286 24 EA 002 579

AUTHOR	Strobridge, Robert; And Others
TITLE	Curriculum Innovation in the Fields of History, Science, Music, and Art Within a Single Institute; And Curriculum Innovation, 1966-1967. Final Report.
INSTITUTION	Webster Coll., St. Louis, Mo.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-6-1754
PUB DATE	16 Jun 69
CONTRACT	OEC-3-7-061754-0196
NOTE	217p.
EDRS PRICE	EDRS Price MF-$1.00 HC Not Available from EDRS.
DESCRIPTORS	Biological Sciences, *Curriculum Development, *Curriculum Research, *Elementary Education, *Experimental Curriculum, Graphic Arts, History, *Instructional Innovation, Music, Newsletters

ABSTRACT

At Webster College, St. Louis, Missouri, the objective of the Webster Institute of Mathematics, Science, and the Arts (WIMSA) is to create curriculum materials for the lower schools in the fields of science, history, and music, and, concurrently, to devise a mode of teacher preparation aimed at producing teachers capable of handling such materials. In the curriculum materials for art and music, an attempt was made to clarify the relationship between physical objects and art form and music, to add to their appreciation. In science, new techniques were devised in developing genetic models and in the presentation of general subject matter by using the common household fly. The final report, in history, dwelt on better success in the presentation of history from an interpretive approach as opposed to the traditional chronicle presentation. This document also includes WIMSA newsletters, a final report on project expenditures, and a summary on some followup studies that were made after the project funding ended. [Not available in hard copy due to marginal legibility of original document.] (LN)

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FINAL REPORT
Project No. 6-1754
Contract No. OEC 3-7-061754 196

REPORT
Curriculum Innovation
1966-1967

WEBSTER COLLEGE
St.Louis, Missouri

Curriculum Innovation in the Fields of History, Science, Music, and Art within a Single Institute

June 30, 1967

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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U.S. DEPARTMENT OF
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Office of Education
Bureau of Research

Curriculum Innovation in the Fields of History, Science, Music, and Art within a Single Institute

Project No. 6-1754
Contract OEC 3-7-061754-196

Authors: Robert Strobridge, Suzanne Creamer, Sr. James Anthony Udovick, Sr. Jeremy Coughlin, Paul D. Merrick

June 30, 1967

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely, their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

WEBSTER COLLEGE
St. Louis, Missouri 63119

FINAL REPORT, Curriculum Innovation in the Fields of History, Science, Music, and Art within a Single Institute, 9/1/66-5/31/67

The stated objective of the Webster Institute of Mathematics, Science, and the Arts is,"the creation of curriculum materials for the lower schools in the fields of science, history, music, and art, in such a way that concurrently is created a mode of teacher preparation aimed at producing teachers capable of handling such materials." The accompanying report with its attached materials would seem to point toward success in this objective. Curriculum materials included with this report were produced during the 1966-67 school year (20 copies with the exception of pictures). Also included are copies of the WIMSA Newsletters which give further details of departmental work and objectives.

ART:
- The World of the Dot
- The Dot Unit as presented to elementary school children
- Names of the Sounds I Saw
- Light and Shadow

MUSIC:
- Line, Space, Texture
- Speech as Related to Holidays (Halloween, Valentine, Easter) with accompanying written music
- Color Unit (white, blue, red, green, black, yellow), with accompanying written music

SCIENCE:
- On the Fly
- The Fly Cycle
- Even Flies Remember
- Flier describing 1965-66 film, "Focusing on Time"

- Film, Linear Look at the Fly
- Film, Building Genetic Models

- Talk, "A View from a Different Angle," given at NSTA convention, New York, April 1966
- Talk, "Building Genetic Models with Fifth and Sixth Grade Children," given at NSTA convention in Detroit, March 1967

HISTORY
- Institute, August 1966

CAMPUS SCHOOL OF RELIGION

WIMSA Newsletters

ART

The Dot Unit

Robert Strobridge, assistant professor of art, presented a three-week session on the dot project to the 6th and 7th grade students in the College's Experimental School. This same unit was presented in April to the students of Lockwood School, Webster Groves, by one of the pre-service teachers, Suzanne Creamer. She presented a full progress report on the unit to the art faculty. (Enclosed.) Mr. Strobridge presented a three-week session on "The Names of the Sounds I Saw," November 21 through December 9 to the 6th and 7th grades of the Experimental School. This same unit was presented to the 7th and 8th grade students of Hanley Junior High School, University City, in May.

Art instructor, Jana Patton. met with the second grade for art during the entire reporting session at the Experimental School. Assisted by two art majors, she began presenting the elements of basic design to the first grade, i.e., "The World of the Dot," (Enclosed.) and the "Light and Shadow" project. (Enclosed.)

Exhibit

A major exhibit was hung in the gallery of the Loretto-Hilton Center for the Performing Arts, October 12 - November 1. It was entitled STRUCTURES - SNAKESKINS, AND SYSTEMS." It was made up of large photostats of images developed by scientists, engineers and artists from our electronic age. Literary quotes from contemporary philosophers, historians, novelists, and poets were also enlarged on photostats and accompanied the images. On exhibit were charts of patterns traced by a magnetic field, cross-sections of biological organisms, highly magnified chemical reactions, etc. The quotes in reference to the images endeavored to show the dependency of one area of human knowledge to others. It was the intention of the art faculty and students involved that the images produced in scientific research, combined with the literary quotes demonstrate the potential of cross-disciplinary curriculum material. The fact that it was in a gallery and exhibited as works of art was essential to our statement. A session was arranged in the gallery for the faculty and students of all departments to meet and to exchange ideas on the exhibit and its practical applications. The exhibit has now been made available as a traveling unit to interested institutions, and to date has been scheduled by four. There is some chance that this may have to be discontinued because of the high cost of shipping a 430 pound exhibit for any distance.

The Names of the Sounds I Saw

The unit, "The Names of the Sounds I Saw," mentioned above, (enclosed), was presented through December 9 by Robert Strobridge. This unit is used to illustrate the point that letter forms have connotative meaning. It attempts to have the students see letters as graphic conveyers more than phonetic constituents. It begins by exposing the students to a variety of recorded sounds from television, radio, etc. The students are then asked to make lists of soft words, thick words, crisp words, complicated words, etc. The main value of this is in getting the group excited with playing around with words. This then can progress to the point where the students make their own words or even non-phonetic sounds. A set of the alphabet in a formal Roman style is made available to the student and he is asked to set his word or sound to letters. This then is the beginning of developing a letter form style which best interprets the word or sound.

Saturday Workshops

A series of Saturday workshops for sixty pre-service and in-service teachers began on December 28, with banner-making. A session on January 4 was given on the same subject. On February 18 and 25, sessions were presented on "Projection of Light and Color." Additional workships, each for two Saturday sessions, ran through the semester. ("Light and Shadow" unit enclosed.)

Show and Tell

On December 5-6, a workshop entitled, "Show and Tell" was given under the direction of Myron Kozman. Mr. Kozman, of the Layton School of Art, Milwaukee, was a WIMSA consultant in November 1965. The workshop involved students and faculty from the history, music, dance, philosophy, drama, English, science, and art departments. As the guest consultant, Prof. Kozman called upon all the departments to contribute their efforts and knowledge toward an investigation in communication. The workshop took place in the main theater of the Loretto-Hilton Center. The theater was chosen as a center for this investigation because of the space, equipment, and an interest on the part of our guest consultant in theater as a logical center for all the arts. The lighting and sound technicians were on hand to aid in the presentation. The students made films and slide presentations which were incorporated with music, dance and readings. Judith Mandeville, creative dance instructor, worked with her students in interpretive dances to music, slides, and films. Prof. David Smith of the history department made a slide presentation on a period of English history, with a background of contemporary sounds. Multiple slide projection on the audience, on screens, and on three-dimensional objects created for that purpose was used, as were slides of biological and chemical nature projected on the dancers as they performed toreading or music. The workshop was well attended by art teachers and supervisors of the local districts. Several of the students aided high school students from University City high school conduct a similar investigation in May.

"Environment" Workshop

A workshop on "Environment" was directed by Karl Linn of Long Island University, February 8-12. Mr. Linn, an architect and psychologist, worked with students from the social science, psychology, music, and art departments. Under his direction, the students began a program which continued to investigate the space on campus and how it could be changed to best serve our needs, reflect the goals of the College and become visually stimulating. The students also toured many of the inner-city areas with Mr. Linn, and have begun to join with programs to help people create "liveable" space for themselves. Six students are spending the summer in an inner-city area working on playground areas and attempting to re-design recreation space with the people. Mr. Linn returned to Webster in April to confer with the students and to see their work. They are also working very closely with Miller Newton of the social science department. Many of the sessions of the original workshop were made open to teachers in the area, and one of Mr. Linn's presentations was given in the inner-city area for the residents there. The students involved with redesigning the space on campus are working closely with students from Washington University's School of Architecture.

Meetings with In-service Teachers

During April and May regular bi-weekly meetings were held with the art faculty of Webster College and approximately 20 in-service teachers in the St. Louis area to discuss needs and problems in the teaching of art and art curriculum.

More "Show and Tell"

In May, the design classes of Miss Jana Patton put on a series of presentations based on many of the discoveries made during the "Show and Tell" workshop under Mr. Kozman.

MUSIC

A. Line, Space, Texture - (Units appended)

1. Line. The children began their study which related music to the arts with a study of line. Records were listened to in order to find whether the lines were smooth, or pizzicato style, whether they ascended or descended, whether it was deep or high. Poetry was read to determine whether the verses were measured or free, architectural patterns examined to look at the various lines of buildings, columns, roofs. They named as many kinds of lines that they could think of, played these lines on instruments of their choice, and finally, in small groups, made themselves into lines as suggested by spiral, dotted, straight, jagged. Critical viewing of lines as used in advertising and television also was a subject of discussion.

2. Space. The idea of space was pursued through art, dance, advertising, and music. The upper tetrachord, lower pentachord, and the middle tones were spoken of as upper, lower, and middle space. Through experimenting, some interesting compositions involving three-part harmony were composed.

3. Texture. In the study of texture, comparison was made with the tone-texture of instruments to the textures depicted in pictures, with the students finally "playing" the textures depicted, on instruments of their choice.

B. Speech as Related to Holidays (Units appended)

On the premise that speech may become a very integral and interesting part of the music lesson if used in connection with rhythm and movement, and body instruments, units using the various American holidays were worked out by Sr. James Anthony Udovick, director of music at the Experimental School, with the cooperation of Sr. Jeremy Coughlin. (Sample units on Hallowe'en, Valentine's Day, and Easter appended.) Besides focusing attention on the various holidays, this unit helped to correct speech difficulties, and developed creativity in the children. The same general method was used for each of the holidays. The children were asked to think of words that reminded them of the holiday. Lists were made, and then sets were tried out to see which words went together, or which had the best rhythmic pattern. Usually, one word, very often the name of the holiday, bacame the ostinato background over which the other words were fitted in. The Carl Orff technique formed the basis

MUSIC , continued

of the work. After different word patterns were decided upon, they were spoken canon style, or rounds, or as a Rondo, with body instrument accompaniment. After the rhythm patterns were established, percussion instruments took the place of body instruments. Once nice rhythm accompaniments were established, the words were no longer necessary, and a song about the holiday was either taken from one of the current texts, or a poem was put to music, or the children made up their own. In this particular series, the music was composed by Sr. Jeremy Coughlin. The next, and final step, was to create a movement that would both express the holiday represented, and would fit into the rhythm of the words.

C. Color Unit (enclosed and with accompanying music)

Just as color has its place in nature and each one can be distinguished by its own peculiar characteristics, so Sr. James Anthony Udovick and Sr. Jeremy Coughlin felt that each color had its place in music and that a particular color could be experienced through a musical setting.

With "Hailstones and Halibut Bones," by Mary O'Neill as the text, these two collaborated on a unit in which an attempt was made to "hear" color. Six colors were chosen - white, red, blue, green, black and yellow, and an attempt made for not only the eyes to distinguish differences, but also ears, and the whole body.

Sister Jeremy composed within the framework of the Carl Orff Instrumentarium and the age level of the children. Upon completion of the compositions, the children were given the opportunity of experimenting with them in order to see which groups captured the spirit of which colors. It was found that the mood of the different colors could be expressed better by some age levels than by others.

At the end of the unit, the children had combined art, speech, music and the dance in a truly unique way. A proof that the children were not tired of the activity after it was over was that the day after they did it for their parents, they wanted to do it again and again, not as a performance for someone, but purely for their own enjoyment.

SCIENCE

During the September 1966 - May 1967 period, WIMSA has continued its activities in the innovation of classroom science materials, with the support of funds from the United States Office of Education and the Carnegie Foundation. In conjunction with on-going research in the curriculum, WIMSA has maintained a "fly laboratory" to supply its own needs and to provide living materials for experimental classes in the St. Louis area as well as other parts of the country.

During this period, approximately 2000 requests have been received for WIMSA science materials and/or information about the curriculum project. It has been the policy of WIMSA to disseminate materials on a voluntary basis; that is, we do not proselytize or provide external services or inducements to get people to use WIMSA materials. In a sense we have adopted a laissez-faire policy toward dissemination, with requests coming in the main through contact with the WIMSA science materials or people who have used them.

A. Teacher Training Packages

1. The Fly Cycle, an 8-page commentary on the classroom film, "A Linear Look at the Fly," is completed. This document and the film together with the curriculum document, "On the Fly," comprise the second complete teacher training package produced at WIMSA. This package is now being used experimentally with teachers in both colleges and school districts. (The Fly Cycle and On the Fly are both appended to this report.)

2. The classroom film, "Building Genetic Models" (55 minutes), was filmed in October 1966 with the eight children from the College's Experimental School who had participated in the development of the WIMSA heredity materials. The film has now been titled and finished and has already been used outside the WIMSA framework. The companion curriculum-commentary-resource document, Even Flies Remember (32 pages, appended), was completed on May 9, 1967 and is now being disseminated. "Building Genetic Models" and Even Flies Remember, together, form the third teacher training package completed at WIMSA.

3. WIMSA continues to disseminate The Shell Game package on a national basis. Appended to this document is the "flyer" which has been used to describe the teacher training package.

4. The initial steps for the preparation of a fourth teacher training package have been taken. The classroom film base for this package, "Gases and "Airs", is already in existence; it is the 70-minute videotape

SCIENCE, continued

made by Paul Merrick while he was a staff member at Educational Services, Inc. Madison Project, the actual funding group for the film, has granted WIMSA the right to utilize any portion of the footage. WIMSA now has possession of the videotape, a film negative, and two complete prints. In addition, E.S.I. has granted WIMSA permission to use its four-minute film loop materials, "The Mouse and the Candle," and has provided us with a master print. The textual material (tentatively called Bringing the Mountain to Mohammed) will be taken from WIMSA work with the fly in the Experimental School and the College. Completion of this package is dependent upon future funding and staff.

B. Other Curriculum Materials

1. Work has continued on the development of the Continuous Laboratory Scheme. (A copy of the paper - Laboratory Work, A View from a Different Angle, presented at the National Science Teachers Association convention in April 1966, is appended to this report.) This six-weeks laboratory block was again used experimentally at Webster College in the fall semester of 1966, as a component of the Biology I course. This block (Unofficially known as The Fly Block) is now an official segment of the Webster College Master of Arts in teaching program.

2. WIMSA has made three short single-concept films related to the house fly and the Continuous Laboratory. Two of these films are the basis of an abbreviated version of On the Fly, known unofficially as The Vicarious Fly. This work has been used locally in the St. Louis area on three occasions this past spring. Two of these short films have been titled and used independently in an inquiry context. They are: a. "The Chicken and the Egg" - a sequence concerned with maggots and pupation; and b. "The Interaction of Wet Steel Wool and Air" - a sequence concerned with consistency and prediction.

C. Contact Activities

1. Paper: Building Genetic Models with Fifth and Sixth Graders was presented at the National Science Teachers Association meeting in Detroit, March, 1967. (Appended.)

2. Article: Fly Culturing appears in the May 1967 Science and Children (Appended.)

SCIENCE, continued

3. Participation: as a consultant, in a National Science Foundation conference to explore implementation of "new" science materials in elementary schools. (University of Maryland.)

4. Presentation: WIMSA science innovation framework at the University of Illinois, Southern Illinois University, Minnemast, University of Minnesota, and the University of Illinois Elementary Project.

HISTORY

A two-weeks history methods institute was held immediately preceding the opening of classes last fall. This permitted senior history majors to attend, as well as the cooperating teachers of St. Louis and St. Louis County, who would have them under their direct supervision for six weeks apprentice teaching immediately following the institute.

Dr. Richard B. Ford, instructor in history at the Carnegie Institute of Technology, was consultant and lecturer the first week. He used film, lecture, and discussion to show why the old method of teaching history as a chronicle of past events which students memorize and give back in recitation or exmaination, is being replaced by the teaching methods of interpretation. He stressed that students must be able to judge whether an author's conclusions are supported by the evidence he presents.

Sister Barbara Barbato, Conal Furay, and Fred Stopsky, all from the Webster College history faculty conducted classes the second week. Facets of teaching that are universal, whether one uses the traditional or the new approach, objectives, resources, references, criteria for selection of textbooks, lesson planning, and classroom techniques were some of the subjects pursued.

Reports from the apprentice teachers after six weeks in the field were almost universally in agreement that practical application of what they had learned at the methods institute made them not only better teachers, but better historians.

CAMPUS SCHOOL OF RELIGION

Fred Stopsky of the College's history department in cooperation with Sr. Anna Barbara Brady of the department of theology, conducted a Campus School of Religion, during which seventh graders studied not only how historians work, but made a study of the conflict situations in the life of St. Paul as set forth in the Book of Acts. Analysis of these historical biblical stories was followed by an analysis along parallel lines of some of their own personal and group problems. This unit along with those from the 1965-66 school year, not previously published, will be one of those ready for distribution in mimeographed form next fall.

Participation in FUTURE TEACHERS OF AMERICA meeting.

Two WIMSA participants appeared on the program of Webster College's annual College Day for Future Teachers of America, held at the Lorreto-Hilton Center for the Performing Arts in early April. Sister James Anthony Udovick, director of music at the Experimental School, involved members of the audience in her demonstration of elements involved in the understanding of music and rhythm. Working with four rhythms, she taught the audience to do them, first in unison, then in canon style to the accompaniment of a record. Next a number of instruments were used, and finally words, suggested by the audience, to the same rhythms. Robert Strobridge of the Webster College art department gave a slide lecture to demonstrate how our culture is changing by contrasting the older generation's don't-interrupt-my-train-of-thought habits to the younger generation's invitation to diversion by doing three or four things at once.

WIMSA mention in the North Central Association of Colleges and Secondary Schools Report

Following are some quotes from a report made by the North Central Association of Colleges and Secondary Schools, following a visit by a committee to the Webster College campus:

"The Webster Institute of Mathematics, Science, and the Arts, a 'vehicle by which experimentation and innovation begun at Webster College can be enriched and continued ' - - produces the kind of material which aids those in elementary and secondary schools who wish to upgrade their teaching. - It is imaginative and creative and certainly one of the very important contributions of Webster College to the development of teachers. The interesting and informative Newsletter has wide circulation, giving broad exposure to the ideas being developed. - - Lecturers and visitors brought to the campus in the WIMSA program are, of course, shared with the MAT candidates and other students in education. - - WIMSA - "directed very ably by Sister Marie Francis."

WIMSA NEWSLETTER

Three issues of the WIMSA Newsletter were published during the 1966-67 school year. These covered innovative teaching materials and/or methods in history, art, social science, music, mathematics, biological science, religion (non-denominational), and pre-school. (Issues enclosed.) Editor and writer, Adelaide M. Whitesitt.

WIMSA NEWSLETTER, continued

Materials on teacher-training in the field of science are available with the first copy free, and copies in bulk available at slightly less than actual printing costs. Three science films, "Focusing on Time," "A Linear Look at the Fly," and "Building Genetic Models," are available for a small service charge, and were offered experimentally to teachers of science, mainly on college and university campuses, at no charge.

Mimeographed copies of the WIMSA Music Program (Rhythm, Western, and Indian units) and the WIMSA History Program, "Project Ancient History" are available on request at no charge. Sample units of the "Campus School of Religion" curriculum in mimeographed form will be available by fall.

The Newsletter reaches not only the 50 states, but persons in 15 foreign countries. Quotes from letters which have come to the WIMSA office: 'The Newsletter is fine and worthwhile." (Science teacher, Sayre, Pa.) "We appreciate receiving the Newsletter which has provided us with a great deal of information and new ideas." (Principal, Cathedral Oaks School, Santa Barbara). " - very interesting and informative." (Yorkville, Ill.) " - the ideas are so useable and creative." (West Lafayette, Ind.) "I find it provocative and interesting." (Mill Valley, Cal.) "Fine and informative issue." (State of New Hampshire, Department of Education.) "Thank you for invaluable service in supplying copies of creative materials to me." (State Department of Education, Oregon.) "It is good to know about your imaginative work, especially for a beginning teacher who often gets discouraged." (Dobbs Ferry, N.Y.)

APPENDICES to: Final Report, Curriculum Innovation in the Fields of History, Science, Music, and Art within a Single Institute
Project No. 6-1754, Contract No. OEC 3-7-061754-196
May 31, 1967

ART

The World of the Dot, 3 pages.
Dot Unit as Presented to Elementary School Children, 9 pages.
Names of the Sounds I Saw, 1 page.
Light and Shadow, 3 pages.

MUSIC

Line, Space, and Texture, 4 pages.
Speech Related to the Holidays, with Accompanying Music, (Halloween, Valentine, Easter), 23 pages.
Color Unit with Accompanying Music, 44 pages.

SCIENCE

Even Flies Remember, 32 pages. Reprinted from Even Flies Remember by Paul D. Merrick, by permission of Mr. Merrick and Webster Institute of Mathematics, Science, and the Arts. Copyrighted April 1967.
On the Fly, 31 pages. Reprinted from On the Fly, by Paul D. Merrick, by permission of Mr. Merrick and Webster Institute of Mathematics, Science, and the Arts. Copyrighted June 1966.
The Fly Cycle, 6 pages. A teacher commentary to accompany On the Fly and the classroom film, Linear Look at the Fly, a terminal lesson.
Flier, describing the 1965 film, Focusing on Time.
Fly Culturing, reprint from Science and Children, Vol. 4, No. 8, May 1967.
Building Genetic Models with Fifth and Sixth Grade Children, 4 pages. Talk given at NSTA convention in Detroit, March 1967 by Paul D. Merrick
The Continuous Laboratory, A View from a Different Angle, 2 pages. Talk given at NSTA convention in New York, April 1966 by Paul D. Merrick

HISTORY

Institute, August 1966

WIMSA NEWSLETTERS

Three issues. December 1966, March 1967, May 1967.

CURRICULUM INNOVATION IN ART, Webster Institute of Mathematics,
Science and the Arts, 9/1/66 - 5/31/67

The Dot Project - THE WORLD OF THE DOT

The dot, as a small, non-directional visual unit, can be the basis for exploring several principles of design, and can furnish the kind of atmosphere that will encourage students to see the dynamics of the visual language.

Possible starting points:
Gravity explorations - the influence of gravity on our "real world" experience shown in many simple demonstrations of body positions, dropping objects, friction, etc.

Random shape cutting - with accompanying questions about direction implied by various shapes. "Can we create a shape with no implied direction at all? " etc., until the concept of implicit direction is established and the students begin to agree upon shapes that are circular, square, octagonal, etc. Then by use of movable circles on squares of paper, many discoveries are possible related to the dynamics of the image and the picture-plane.

Our field of vision is another starting point wherein some experiments can lead to finding out where each student's peripheral vision begins and what generally is seen as we exist in the "real world." Reminders that TV screens and Cinemascope screens effect the direction of the field may bring up questions about the kind of "field" or picture plane that has the least implied direction. Once this concept of implied direction is sensed with the plane, an advance toward the idea of an image (shape) that has no implied direction should follow without much provocation.

Many of these early discoveries about dynamics will not result in "permanent" pieces of work. By having movable dots and small individual picture planes, several discoveries can be made with each subtle change of relationship between the dot image and picture plane. Paper-punched dots are easily produced in quantities, and it is also possible to have the students cut "as perfect as possible" dots from black paper just to challenge them. In any case, keeping the dots movable is beneficial during these early discoveries.

Dot: picture plane

The first work with one dot on the plane should bring many questions about sensing the space of the plane and might even bring some comments related to gravity - "Down there in the corner" or "floating up near the top", etc. These are basic to understanding the visual metaphors - the use of images in limited space to describe "real world" experience.

THE WORLD OF THE DOT (continued)

TWO DOTS

The dot/picture plane dynamics become changed by the introduction of a second dot. Students should see many things happening to the new interrelationship as they move the two images close together, into the same corner, separate them, etc. The metaphor potential should be obvious to many by this time, and perhaps pasting down a few different "dot pictures" would lead to visualizations of "friends", "two birds", "Cat in a tree with dog on the ground", etc. These are important, once again, to the understanding of visual language. Notice how the students will vary in their perception of metaphor.

MANY DOTS

The picture-making activities will surely call for use of more than two dots and this will open up still further possibilities for discovering ways to create the illusion of depth and ways to suggest shapes by the images' relative locations.

ILLUSION of DEPTH

This whole consideration can become focus of several sessions in which many of the techniques for achieving the illusion of depth are explored by the students. Such means as: overlapping, diminishing size, value change, high and low placement on the picture plane, ornamentation of certain dots to "bring them forward", etc. This is also a time to introduce more media, since cutting and pasting is not the only way to sense graphic space.

UNITY/DIVERSITY

Variation on a theme. An extremely valuable skill to gain in the use of the visual language is sensing that delicate point when the unity of the plane is destroyed - and also to sense the point when diversity is called for.

One approach to this sense is through theme and variation (just as in Mozart). In fact, I have used musical variations to explore the idea of theme in visual imagery. "What is the theme of a dot? " "How much can we alter a dot before it loses its characteristic theme? "

Exercises in style. The same story is told 99 different ways in a little book called "Exercises in Style" and this makes a further reference to the general sensing of unity/diversity in writing styles. The students enjoy reading the variations to the group and further visual language implications can be drawn from the whole idea of style.

THE WORLD OF THE DOT (continued)

The halftone dot pattern. An extension of the use of dots in better understanding the visual language is possible by a study of the technique printers use in reproducing halftone images. The whole struggle of the graphic arts industry through the past 100 years to better reproduce grey tones makes an interesting demonstration of the use of single dot units to give the illusion of modulated values in the "real world". The more skillful students have enjoyed scaling-up a section of a halftone pattern into a large mural and then watching others discover the emerging unified image.

This extension is one of several which could result from the basic concentration on single visual units. Another welcome extension was used recently when the students were asking more about the pointalist painters, whose work was shown in connection with the development of halftone reproduction. They did some handsome color "point-paintings" and were very pleased to move away from strictly black and white work!

THE DOT UNIT - as presented to elementary school children of the Lockwood School, Webster Groves, Mo., by pre-service teacher, Suzanne Creamer

SESSION 1.

Confronting the children immediately with a question with innumerable answers, I began the session by asking them what "high" was. The first few answers pertained to their immediate knowledge or surroundings - their parents, the ceiling of the school room. When airplanes were suggested, I brought it to discussion by questioning them on specifics - a single prop plane, or an Air Force jet? Then speculation went even further with offerings such as the atmosphere itself, the moon, etc.

The concept of "low" was then thrown at them for definition, and again the first responses were related to the surrounding environment. When the floor was suggested, I asked if the floor of our classroom was "low" to the class below us. Even the ground itself can be outdone by the depths of the ocean or the pit of a volcano. What I brought the discussion to was a realization of the field of vision - that exact amount of area brought to us by our sight. I pointed out that this in a large way determined what we call "high" and "low". To discover the shape of that field I had the children, standing in place, and staring straight ahead at a fixed point, spread their arms and wriggle their fingers, bringing their arms together until the moving fingers could just barely be first seen while still staring straight ahead. This was done first vertically, then horizontally, until the consensus was that a horizontal oval is the shape of our field of vision. I pointed out how this is directly reflected in the magnetic shape of the television screen and even the movie screen.

With this much knowledge of shapes in relationship to their own field of vision, I asked them to cut from the black construction paper I gave them, a directionless shape. After trial, error, and much discussion, they firmly agreed through mutual efforts, that the shape I assigned the arbitrary name of "dot" to, was the self-contained directionless shape we were seeking.

As an assignment for the next session, I asked them to look around and bring in a picture or whatever was their favorite example of dot or dots.

SESSION 2.

As a continuation of the first session, the children brought in examples of dots to comprise a "dot show" which we discussed after it was assembled. Many of the children brought in pictures collected from magazines (I have noticed that many grade school children are "magazine oriented" when asked to bring in examples of something for class), although the most imaginative examples were those thought of by the ones who had either forgotten to prepare something or who just hadn't done the assignment. These ranged from the large polka dots on one boy's shirt to a girl's bracelet (which I considered an excellent example of space orientation of a "flatly" presented concept), all the way to the dots on the ceiling acoustical tile which were, upon closer examination, not dots at all in the sense of geometric circles but random shapes small enough to be undistinguishable in contour from a distance of five feet or more.

During the discussion of the examples the children came to the realization that we were dealing with more than merely arbitrary and/or graphic circles, but actual dimensions of space relative to environmental conditions. For example, dots may be as concrete and tangible as the period at the end of a printed sentence. I wish now that I had pressed the point just far enough with them to see what happens to this dot when the sentence is verbalized, or as elusive as the negative space formed by touching the thumb to the index finger. At this point the children went wild with random spontaneous examples that were usually verbalized as soon as they thought of them. I felt this was a good release for the sudden relevancy that dots were having for them, so I continued to let them speak out their ideas for a while. Then I began to pull together threads of their examples and we were able to categorize broadly into "functional or useful" and "just there" dots. The first category included knobs and dials from mechanical apparatus and other things that corresponded to the shape of the hand and natural tendencies of the fingers as well as its pivotal capacity for movement. This led to the discovery of the elbow and then the arm as having the intrinsic ability to make natural circles (dots) in spontaneous muscular movement (i. e. the throwing of a baseball, stirring cake batter). We found few examples out of the ones suggested that truly fit in the "just there" category. For example, the spots on animals have their purpose in camouflage. Arbitrarily terminating this discussion in deference to showing the slides, much was left yet to be said, and I hope, even more to be thought.

The imaginations of the children were equally unbridled in telling what they thought the different slides of dots, partial dots, and dot patterns were. I did find, however, that those too overwhelmed by the competition to be called on to tell their ideas earlier had now more incentive to express their ideas and almost every child in the class had at least several things to say throughout the showing of the twelve slides.

Some of the lovliest and most imaginative suggestions were: - on a slide of dew drops on a spider web, one girl said timidly, it looked like Chicago, while one of the boys claimed it was the top of a circus tent as you looked up. On a slide that was several of the negative black spaces between dots, one girl said it was what you would see if you were underneath the bubbles in a bubble bath, looking up. For one slide of a partial dot pattern, a boy insisted it was espionage code, while another said it was the pattern on somebody's pajamas. Big black dots, were, according to one boy, burnt pancakes.

I now feel the slides are an invaluable part of this curriculum for several reasons. 1) with the lights off, timid children are more willing to express their ideas; 2) just the fact of the novelty of being shown slides without an accompanying instructional lesson was valuable perhaps as a link to the imagination unleashed by the movies or TV; 3) the children were now relieved of any preconceived ideas on dots as just little round circles confined to flat paper which could readily be very boring.

In that all their ideas were accepted by me as well as the others in the class, I feel that this was a major session in establishing rapport between myself and the children and between the children and their own ideas.

SESSION 3.

This session began with a discussion of dots as illustrated by a large square felt-covered board on which were placed various-sized dots of black felt. I brought in as a starting point, the fact that we had complete control over what happened on that surface of the board, that picture plane. This was in contrast to the diminished effect of the felt dots when placed at random on some surface in the room which tended to be somewhat cluttered by other things to see. The "static" of this clutter is removed when the dots are placed on the sterile white picture plane. Thus by setting working limits to what we want to accomplish, we can often increase the effect of the final product. The examples used on the picture plane were: a) a singular dot, varying in metaphorical effect depending upon its position on the picture plane; b) two dots, also varying in effect depending upon positioning; c) three dots, wherein the idea of closure was brought forth in showing how we tend to connect shapes to make meanings: in this case, a geometric triangle was formed by the three dots; d) one large dot and one small dot. The question I posed to the children was which of the two they would want to identify with, (be), if the two were engaged in battle. Generally, the girls preferred the small dot in relying on cunning and guile to win, while the boys chose the brute force of thelarger. e) One large dot plus as many small dots as would equal the large dot in volume. This I calculated by eye in overlapping small dots on the large, compensating approximately for the spaces between dots. This I would wish to be done mathematically for future sessions as the children were eager to find out if my claim of equality was indeed true. Their final proof conceded that only an approximate evaluation could be reached, but I would hope that sometime this could be worked out so that this proof could be done mathematically.

The working assignment of the day was to draw on a 6" x 6" white tagboard picture plane a circle that nearly filled the square. This was to be done twice, each circle in a different media. The circle was to be as round and as black as possible thereby establishing a criteria by which the different media could be used. I now would recommend for future use of this curriculum that a discussion follow this working session in which points of accuracy and blackness and length of time necessary for completion could be discussed in evaluating the media available - #2 pencil, magic markers, tempera point plus small brushes, and black crayon. I was able, however, to point out the advantages and disadvantages of the media chosen by the children I talked with individually as they were working. I stressed the point of making the circle as perfect as they could, rather than asking them to make a perfect circle. Personal standards of workmanship entered into this challenge as evidenced by the range in accuracy and shape of the dots produced.

The favorite media, as I suspected, was magic marker, followed by tempera paint, then pencil and finally crayon. My reasoning is that magic markers are currently popular because their very shape makes accuracy difficult yet they are easy to work with in quick and effective black movements. Crayons, on the other hand, are the traditional media used in schools so the child is pretty well fed up with them by the time he reaches fifth grade. Tempera speaks for itself as an organic material - slimey, messy, and fun.

The dots as a whole were not perfect circles and the outer edge was not usually perfect as the children started in the center, working carefully, and got less patient as they filled out the circle. The point of truth came for the children in evaluating their work as the dots were lined up in a long row, side by side, along the blackboard. On this level, the children were more concerned with completing the project than they were with the quality of their work while they were working, but became more concerned with quality when looking at the final result.

SESSION 4.

In this session the class was to make a mural of an eye as formed by the dot pattern used in reproducing photographs for printing purposes. The mural was composed of 36 sections of a sequential puzzle following a vertical/horizontal grid. The children were given 2" x 2" sections of the photograph reproduction and asked to reproduce this square in tempera on a 6" x 6" piece of tagboard, according to proportionate scale as gaged by eye or whatever device they would want to employ. At this time they did not know what the sum total of their efforts and enlargements would be, but I did tell them it would be "a something," the final quality of which would depend on their individual efforts.

In presenting this project to the class there was no discussion preceding the assignment and only that which was required for explanation following the giving of the assignment. I asked them to use pencils in making preliminary sketches so that they could evaluate and adjust their approximations before completing their work in tempera.

The small photographic squares and the 6" x 6" pieces of tagboard were distributed by members of the class whose weekly duties included such jobs, while the rest of the materials were at the front of the room to be picked up by children coming up for them a few at a time. This method was as efficient as possible, I believe, since some could be working at their desks in pencil before collecting the tempera, pallette, and brush. However, I think spending a few moments double checking materials (quantity and condition) would have been more efficient.

The children had a great deal of difficulty translating the small photographic section of the dot pattern to their own tempera enlargements. I offered the suggestion to them as a class that they keep in mind that the dots on the small square must be enlarged three times in making it proportionate to the dots on the larger square. Also, I pointed out to them that there was a certain diagonal grid pattern evident even in the small square that would be useful in determining positioning in the large square. Despite what I felt to be obvious helps, most of the children could not co-ordinate both size and positioning, and in several cases could not effectively proportion either. To most of those having difficulty in determining the size of their dots on the tagboard piece, I suggested that they single out the largest and smallest of the dots on the small square given to them and see if the relationship between corresponding dots on their large piece was the same. This seemed to be the most effective device in helping them, although the problem had so many aspects of technical perception - the overall proportion of black to white, the grid pattern, spliced dots on the edge, positioning, size of dots - that even if they were able to perceive and reproduce several of these facets the overall enlargement still did not bear much resemblance to the photographic square. In this sense the class failed despite the great deal of concentration and effort that they brought to the challenge. However, due to a mistake on my part in not realizing that the order of the key grids for both the photographic and tempera squares must be reversed to correspond with the intended image, the class was spared what I feel could have been a detrimental sense of failure, as a whole. However, since the mistake was consistent in both grids, I did have the chance to compare what turned out to be two very abstract dot patterns though the "pattern" of it was at this point dubious. It was clear that there was little correspondance between the two completed keys.

I took the photographic puzzle home and repasted the squares until they formed the correct picture. The first segment of the next session I spent explaining my mistake and showing them the correct and completed dot pattern of a human eye. They were delighted at the eye and more than generous in allowing for my error in making the grid though they had been confused in the meantime about the "something" I promised them the picture would be. Without knowing my error, the next day their teacher had asked them to write down what they thought "it" was. The answers were very redeeming as well as imaginative:

a monster with too many eyes
a black dog in a snow storm
white clouds in a black sky

I feel that what might have been a disasterous session evolved into a positive learning experience (guided by the honesty with which I was forced to admit to them that I, the teacher, had indeed goofed), and by the sense of teamwork and imagination with which the class rescued their project from being a dismal failure on my part and theirs.

SESSION 5.

This session began with an explanation of the errors of the previous week, as I have already explained in the last report. Having finished that business, I passed out a small magnifying glass tripod (a "looker") to each row plus a magazine page to each student. They were simply told to look at their page and possibly trade pages with a neighbor in comparing what they saw. Their observations as a class led up to an explanation by me of how color printing, using a three color dot pattern, is used in magazines and other forms of publishing. They were immediately aware of the relationship between the eye mural and the use of the dot pattern in creating black, white, and shades of grey values.

Then pencils, black ink, stamp pads, and 10" x 16" pieces of paper were passed out to the class. Picking up on the Civil War unit the class had just completed in history, I asked them to make a "picture of an idea" (i.e., an image) using dots to express a whole thing or object that was made up of two distinct parts, still maintaining the feeling of unity enough between the two parts to keep the image self-contained. I gave them the alternative of using the Civil War theme keeping in mind the quantitative and qualitative differences between the North and South, or expressing some idea of their own. I am glad now that I chose to go ahead and give them this choice even though I was doubtful. The most original works were those not directly expressing Civil War images which became pretty stereotyped - crossed flags and a line dividing a map of the U. S. Some of the most imaginative examples were: a pair of lips, an ice cream cone, a man - one half of which was skinny and one half strong. The images were almost all recognizable, tangible objects that were well executed, using the eraser end of a pencil as a rubber stamp. Many of the children had trouble getting started, as I doubt if they had ever worked with "images" as such before. However, once they got started, the ideas began to literally flow and often they got carried away in making their images redundant rather than beginning a new one. Their working time was quickly over, so at the beginning of the next session I used several of their images as examples in illustrating some of the things I had told them at the first of the preceding session - that the most effective image expressed only one idea and needed no caption of explanation or any extra lines of demarkation in denoting the split in the image. The most effective image said, "Pow, here I am" - and that's all.

As an initial experience with simple images, they did grasp the essentials and I felt they could possibly have used another session to extend their knowledge and experience even further.

SESSION 6.

This session was an experience in listening, to understand through the musical media how themes may be developed and varied. At the beginning of the session I showed them two large color poster reproductions that I would leave with them to hang in the classroom. They were delighted by Von Gogh's "Iris," and somewhat puzzled by the combination of the realistic and the abstract in the painting by Toulouse-Latrec of a woman walking in Paris. I pointed out how her cloak lacked detail yet convincingly conveyed the feeling of loneliness and despair. The picture kept them wondering.

The first variation was on a Beatle theme, "Hard Day's Night," as done vocally by the Beatles themselves, then instrumentally in Oriental fashion, and finally in big band style. Technical difficulties were almost more of a pervading theme than musical variation. The phonograph that I was assured they used all the time, did not maintain a consistent 33 rpm speed. Then a school phonograph that appeared to be of excellent quality was brought in. However, the static within the speaker made it sound like an old radio, there was a complete lack of a bass, and the control was out of order. To top it off, this Oriental version was on a standard 33 rpm disc, but the hole for the spindle was a millimeter or two too small, and thus the disc had to be by-passed all together.

These technical difficulties greatly cut down on the efficiency and effect of the session although the basic idea of theme development was evident.

The other theme was the song "Tonight," from "West Side Story," by Leonard Bernstein. This was heard in the original Broadway version (vocal, and instrumentalized) by Dave Brubeck and Andre Previn. I pointed out to the class the difference of treatment of a theme between Brubeck and Previn. Brubeck's version had a consistent melody line carried by a saxophone with the improvisation coming from the other instruments in the group, while Previn's piano was the main center of improvisation as well as of strains and snatches of melody line. I had the class listen for the original melody of the song within the Previn version and raise their hands when they thought he was picking up the melody. This quickly re-engaged their interest which had faltered. It is easy within such a class to let listening become dazing. The children sometimes disagreed about the point of melody, which served as almost a competitive basis for listening intently.

As a conclusion, I asked the children which of the three versions of "Tonight" was the "correct" one. They had varied opnions - the majority of affirmations going to the third (Previn) version, the one to which they listened most closely. I then explained that indeed there was no "right" or "wrong" version, that the choice of expression is ultimately up to the artist himself, depending on what limitations he wants to impose on himself, on what he feels the most effective medium or the one best expressing his point of view. I was quite aware that this summation I gave them was didactic, but I felt, in addition to directly relating this session to the previous sessions, that I was here in control of the material in speaking so directly to them. This was, I felt, a necessary contrast and complement to the helpless position in which I had found myself when the technical difficulties of the phonographs were almost more than I could handle.

SESSION 7

Though e.e. cummings is so complex in his simplicity that often adults fail to understand his poetry, I felt that the four poems I chose to read to the class were affinitive to children's ideas and expressions (#4, #26, #52, and parts from #62 of the book 100 Selected Poems by cummings. Reactions were varied and unique, ranging from delight (#52 they insisted I read twice) to angered frustration. I was glad that those who did not like or comprehend the poems were angered rather than apathetic. Creativity is much more likely to spring from anger than indifference.

I offered a few comments of my own to the class, asserting that cummings made his own rules rather than just breaking established grammar. He took sentences and ideas. broke them up into pieces, and made from them a new way of seeing. We were going to do just that with an 9" diameter black construction paper dot - break it up by two vertical and two horizontal lines, placed at will, and make a new picture by pasting the pieces on a 12"x12" picture plane after making them into a design.

Many of the designs were very symetrical, many were made into faces, and some were pasted at random. The majority of the resulting designs did consider the entire picture plane in placement of the pieces. I think now it would be an interesting project to do this same problem with a 4" black circle, to judge whether the children were more concerned with filling the picture or making an integral image.

SESSION 5

Realizing the need for some kind of measurement of enduring effects of the previous seven sessions, I set this last time together as a chance to get, what I hoped would be spontaneous feedback. Supplying the children with brushes, black tempera paints and 12"x12" white paper, I told them that this was a "free" or "fun" session in which they could do anything they pleased with the materials given.

Without having any pre-conceived ideas as to what to expect, these are the observations I made while the class worked and upon further examination of their paintings, later.

1. The most significant occurence throughout the unit was the utilization of the entire picture plane. That is, a sensitivity to the shape and size of the paper given.

2. There was still a great deal of symmetry evident. I still wonder if this is due to a basic inhibition about "what a picture is supposed to look like" or if it is a calculated experimenting with effects and interactions of shapes.

3. An overt awareness of a point of view of a scene or particular field of vision was utilized by several children as the starting point of their pictures. What appeared to me, upon first impression, to be a tree with a frame around it plus some unidentified shapes, turned out to be the view from and including the window of an airplane - with the wing of the plane cutting through some clouds.

4. Negative space - the creating of shapes by putting all around the contour of the shape you want - was used by the children in some very striking ways, particularly to add an aura of mystery to monster pictures.

5. The dot in all forms was to be found throughout about 1/2 to 2/3 of the paintings. The children created illusions of depth, made shapes formed by small dots, used dots to fill in the space of their picture not directly taken up by larger shapes (perhaps as an indication of air), experimented with the effects of random dots created by the spattering or throwing of paint onto the paper, and finally, several even signed their names on the back of a painting by using small dots to form the lines of the letters of the name.

I believe these observations speak for themselves in relation to the previous lessons. My only major adjustment in the curriculum as a whole would be to insert just such a free painting session as this one at the beginning of the rest of the sessions as a means of comparison.

CURRICULUM INNOVATION IN ART, Webster Institute of Mathematics, Science and the Arts, 9/1/66 - 5/31/67

The Names of the Sounds I Saw

At the outset of an introduction to letter forms, a sound environment can be supplied in the classroom. Taped recordings of television commercials, theme songs, or records of spoken or sung words could be used. These sounds can be a point of departure in the making of images to the sounds. This sequence is designed to illustrate the idea that letter forms are graphic conveyers as well as phonetic constituents. That is, words can have a sound that we see!

Activities in the introductory session will be in the area of "who knows the words" and listening collectively to as many different kinds of words as possible: soft words, thick words, crisp words, lazy words, complicated words, etc. These will be used in subsequent sessions, but the main value is the group excitement of playing around with words. The students could be asked to bring six great non-phonetic sounds ready to perform and record for the second session.

After the recording session the students are presented with a set of standard, straightforward, no-nonsense letter forms. Then by selecting three or four distinctly different sounds from those recorded, a study is made of the kinds of modifications in the standard letters necessary to best illustrate the sounds.

Part of the orientation to using letters to create non-words involved reminding the students of the way vocal sounds (even when they are unintelligible phonetically) can be varied to give different meanings. As the student-made sounds were played nack, the group began to select the letter-cards they needed to create a non-word to name the sounds.

We must admit that there was downright fun in preparing to make "tired 'c'" and "fat 'e'". Here again, nothing permanent as art work accompanied this session, but the learning was rapid and the subsequent "art work" was encouraging. The process of making rhythmic patterns from variations on one letter, was not as simple as it sounded when we discussed doing it. Looking for differences in the kinds of patterns easily made by the letter 'C' and those made by the letter 'L' was not easy, and the distinctions didn't arouse much interest.

An interesting sequel to this project might be to work with an imaginative literature teacher and have the children begin to develop 'sound' poetry with the new sounds they have developed. It might also be interesting to have them write songs using their own sounds.

CURRICULUM INNOVATION IN ART, Webster Institute of Mathematics, Science, and the Arts, 9/1/66 - 5/31/67

LIGHT AND SHADOW

Light and shadow, existence of which is often taken for granted, is an ever-present tool in the visual world. The exploration and manipulation of light and its effects clarify and expand the vocabulary of elements of visual expression and provide an exciting vehicle for interrelated experiences.

Possible beginnings:

Vision as one of the senses and how light controls and affects our vision; this approach could be very meaningful if paralleled with another class investigating the scientific aspects of light. "Does the amount of light affect your hearing? - your taste? - your touch? - what you see?" A completely darkened room provides a most convincing atmosphere for this approach.

The relation of time to the position of the sun and its resultant shadows is an extremely natural and exciting introduction to the world of light as an important element of visual communication.

A warm sunny day and a walk outdoors can provide an environment for the investigation of natural light and shadow occurances. Questions related to the situation could be: "What kinds of shadows do different objects make? - trees? - telephone poles?- - people?" What kinds of surfaces show light and shadow?" "What shadows have sharp edges? - fuzzy edges? - why?" This last question could provide the basis for a discussion of spatial relationships of which we are aware BECAUSE of what we know about light and shadow.

What, where, when, how, why?

The first work in this sequence, regardless of the method of introduction, should contain many questions pointing out the important role of light in our visual world. - "What do you need to see?" (eyes, light, objects) "What if there was light but no objects?" "Does the size or position of the light source make a difference? - what kind? - why?" Experiments with simple materials such as desk lamps and paper shades produce exciting explanations of these phenomena.

Young children seem to require permanent proof of their experiences, so additional activities might seem necessary. Recording the outlines of shadows is an effective solution and can provide many new insights - if you take too long on your drawing, the sun moves and the shadows change - the object which is making the shadow should not be moving, etc.

Value

The potential for directing and arranging light and shadow becomes apparent through a sequence of experimentation with surface variations . Through manipulating a number of white cardboard squares at various heights and angles from a flat surface of the same material, the students become aware of the many possibilities and variations of pattern and rhythm. The limitations of one shape and one kind of surface challenges the student to discover the many subtle variations of the media.

Surface

Through the introduction of different surfaces, the student becomes aware of another means of directing and manipulating the effects of light and shadow. Combinations or collages of two-dimensional surfaces such as aluminum foil, sandpaper, burlap, mirrors, various colored papers, etc., can be explored to discover how each of them responds to light. Perforated materials such as wire screen, punched-out paper, loosely-woven fabric, and transparent and translucent materials such as cellophane, gelatins, glass, etc., can be explored to demonstrate how light is transmitted and different shadows can be produced and controlled.

In working with younger children, exciting things are discovered when one shape or a piece of paper with one hole is moved towards, away from, and at angles to a light source. The variation in shadows from this one source can be recorded by tracing the shadows with colored pencils or crayons. Much of this work can be done outside using natural sunlight as the light source.

Division of space

Involvement in this aspect of the sequence requires as little or as much time as indicated by the enthusiasm of the student. Any of the former materials with a brief introduction to their possibilities for three-dimensional construction will act as light and shadow directors. Shadows as linear or shape elements, spatial knowledge and illusions, and some simple structural principles can be explored in many variations through the use of moving and colored lights - a space full of shadows may seem cluttered or closed in, a space with few shadows may seem bare and dull. Light and shadow must be thought of in relation to the objects causing or revealing them, etc.

Photograms

Disillusionment can easily take place when the light source is gone; the objects and shadows disappear. An exciting approach to this problem could be the introduction of a method of permanently recording or "capturing" the results of natural or experimental light and shadow effects. Through the use of a light-sensitive paper which requires no darkroom to develop and no special light to expose, the student can permanently record his experiments.

At this point, the student may well relate his past experiences in this sequence with the technological possibilities and limitations of the world of photography, film, and television. The value of this sequence lies first in the realization of the expressive potential of light and shadow, and secondly, in the implication of further experimentation and application which can lead and expand in many directions.

Units from the
WIMSA MUSIC PROGRAM

Experimental approaches to music as related to the arts, conducted by the director of music at Webster College's Experimental School, Sister James Anthony Udovick.

UNIT 1
LINE, SPACE, TEXTURE

A. LINE

"How many different kinds of lines can we think of?" From this question evolved an interesting unit of lessons which included art, creative music, and dancing.

The answers came quickly. Lines could be straight, wavy, zig-zag, horizontal, vertical, criss-cross, dotted, thin, thick, spiral, parallel.

A big sheet of paper was produced and fun was had by the class in drawing the lines suggested, overlapping them, criss-crossing them to make various and unique patterns.

"How would you play a circular line?" This question started some real creative thinking. Using various percussion instruments, the students played their interpretations of the kinds of lines drawn. The results were quite worthwhile.

The drawing and playing of the different types of lines led inevitably to dancing them. It was interesting to see how concentration on expressing the line idea with body movement completely eliminated self-consciousness and the usual inhibitions of boys in particular.

After allowing sufficient time for the children to experience line in the various ways in order to create an atmosphere in which ideas would germinate, they were divided into groups of five. LINE would be the theme, art, music, and dance were the mediums, and each group was to start from a different point. Thus we had:

Group 1: art, music, dance; group 2: music, dance, art; group 3: dance, art, music. Therefore, Group 1 knew that whatever they created in art would later be interpreted through music and then dance. Group 2 knew that their music would be danced and then drawn, and Group 3 danced their line ideas, then drew them, and later let the music grow out of both.

As each group composed the music, it was taped. When all the groups had finished the three sections, the tape was played, and each group had a chance to dance in front of the line mural. The effect was very modern and satisfying. One group wanted to do their dance in the gym on a large piece of paper after stepping into pans of different colored paints. Great fun was h as, with feet ready in pans of bright colored tempera paint, the children waited for their music to begin. The result was a realistic, if not an esthetic work.

This unit provided much opportunity for working together, interpreting the movement as individuals while, at the same time, creating a unified whole. Imagination was sparked and freedom of expression was evident.

After experiencing the feeling of line within three art forms, we turned to the music of composers. We spoke of the melodic line, how it could be simple or dramatic. We heard the contrast between the simple and melismatic lines of Gregorian Chant. Later I selected several pieces from the ADVENTURES IN MUSIC series and asked the children to draw the melody line of the music I was about to play. In looking over the papers afterwards, I could see that the children got the mood of the music in their line drawings. Smooth music was pictured by lovely flowing lines; staccato music by a series of dots and dashes, and so on. The children became more conscious of the contour of music by this means.

Had time allowed, I would have studied the different lines of architecture more thoroughly, such as the baroque, the classical, the modern, in order to see how the music, the art, and the dance of the periods influence and are influenced by each other.

B. SPACE

"What is space? "

The answers that were given to this question showed how various are the ways that we use this word. One child said it was the part where the astronauts were; another that it was the part of the room where no one or no thing was. Still others said it was the part between things; a vacuum; the part between the lines on a staff. We thought of it in terms of high, middle and low space. It was surprising how many things a class can come up with in speaking of such a simple thing as SPACE.

Pictures from magazines were spread out on the floor and the children were asked to pick one. After doing so, we discussed space from the viewpoint of what objects were occupying space in the picture; what ideas of space the pictures suggested. The terms positive and negative space were used, positive space being what dominated the front or main part of the picture, negative space as being the background. We saw then that music can have this idea. The main theme of the music would be the positive space, or the solo instrument, or the melody line. Negative space was the background music, the part of the music that lent contrast or beauty to the main theme or main instrument.

We studied space on the staff, changing key signatures in order to see how the position of number names of the scale were changed with the changing key signatures. Next, we studied music from the idea suggested by high, middle, and low space. High space for us was the upper part of the scale, the upper tetrachord. The lower part was the pentachord, and the middle part of space was the middle part of the scale which contained the two main tones after the tonic note. Thus: 5678 upper space; 345 middle space, 12345 lower space.

We decided to see if we could make some interesting music by working with the three sections separately. The class was divided into three groups. A time signature and a key signature were chosen , also the number of measures, and the groups set to work writing music with just the notes of the section they had to work with. The finished melodies were then sung in all the various ways possible, that is, from the top to the botton, from the bottom to the top, and then beginning with the middle section and singing up then down, and vice versa. Since one of the groups had ended their piece on the 1, it was placed as the last line, since the other two lines left one feeling unfinished. The idea then came up to have each group sing its line at the same time. The surprise was evident when, in singing it, we saw that we really had created an harmonic sound that was pleasing and fitted together nicely.

The melodies were then played on instruments. Since the children had put the melodies in a key and written them out on the staff, it was simple for them to play each others melodies by reading from the staff. We did this in different keys, thereby gaining in knowledge of staff reading, time signatures keys, parts of scales, tonal centers, chordal arrangements, while at the same time having fun composing music together. The first music had been created in a group situation. Afterwards, each child composed a melody using the key and the mode of his own choice. The results were gratifying.

C. TEXTURE

Sitting in a circle on the floor, we let our fingers work. We touched different types of objects in an effort to express the feeling. After this finger exploring exercise, we let each pupil at a time close his eyes. The pupil was then handed an object and he was to say the first word that came to his mind. This word was not to be the name of the object, but how it felt. Words that were given were: hard, soft, smooth, slick, velvety, etc. This exercise started the class thinking of many different words to express what the fingers felt, and once they started thinking, many interesting words came forth.

After using objects to identify texture, we next looked at the advertisements of the current magazines. We wanted to use our eyes to see how advertisers are able to give the impression of texture in their pictures. We saw how it was possible to convey rough, smooth, bumpy, sharp, knotty, etc., from the advertising point of view; whether or not the picture expressed the tone of the object being advertised; whether the picture aroused in us any desire to purchase such and such an article.

Could texture be expressed in music? We would try. As the eyes and fingers can distinguish, so can the ear. As objects have different texture, so instruments have different timbre, which has the same effect on the ear as different surface areas had on the fingers and pictures had on the eye. We experimented with various instruments in order to see how many different kinds of texture we could get from them. Certainly, the bass xylophone did not sound like the soprano glockenspiel; the wood block gave a different emotional reaction than the triangle, and so on.

The students spent time analyzing the sounds of the instruments, trying some together to create a special effect. Next, each pupil was asked to draw up a list of ten words that would express texture and next to the word put the instruments they thought would give that feeling. Of course, the ideas and words varied considerably, but the children were able to see how much richer a composition can be if the right kind of effects are used.

Many ideas came forth from this unit. One that worked well was to take one of the pictures we had studied at the beginning. The picture should be one that had several textures involved. Then, we "played" the picture. A child would pick the object he wanted, and the instrument that would best typify for him that particular texture. If the object played a rather dominant part in the picture, his instrument could do likewise. The background in the picture would be an ostinato and could be played on any of the instruments. All these things awaken awareness to sound, release tension sometimes created by trying to play without mistakes, and involve children in group activities and working together in order to make something either beautiful, interesting, or even chaotic!

When you try something yourself, you sometimes get a greater appreciation of those who have succeeded in doing what you tried. And so, we turned to the composers, those musical giants who used instruments so well and gave us such beautiful musical texture. This too, can be done in different ways. The children may just listen, and tell about the instruments they heard afterwards. Or, they may be asked to listen for certain sounds or effects. With the older children, the periods of music may be listened to while showing the pictures of the period which show architecture, furniture, dress. What variety can be found by listening to baroque and perhaps something from the impressionists. The periods may be studied in sequence or out of sequence to show comparisons and contrasts. Any number of ways may be used. Excellent records for this are the Time-Life records, "The Story of Great Music.

HALLOWEEN

There are so many interesting word patterns and sound effects for this holiday that much fun can be had just trying them all out and getting ideas. We started out by making lists of words. Some of them were:

- Black cat
- skeleton
- broom stick
- witches
- trick or treat
- costume
- haunted house
- goblins
- pumpkin
- scary
- Boo!
- ghosts
- moonlight
- Halloween
- October 31st

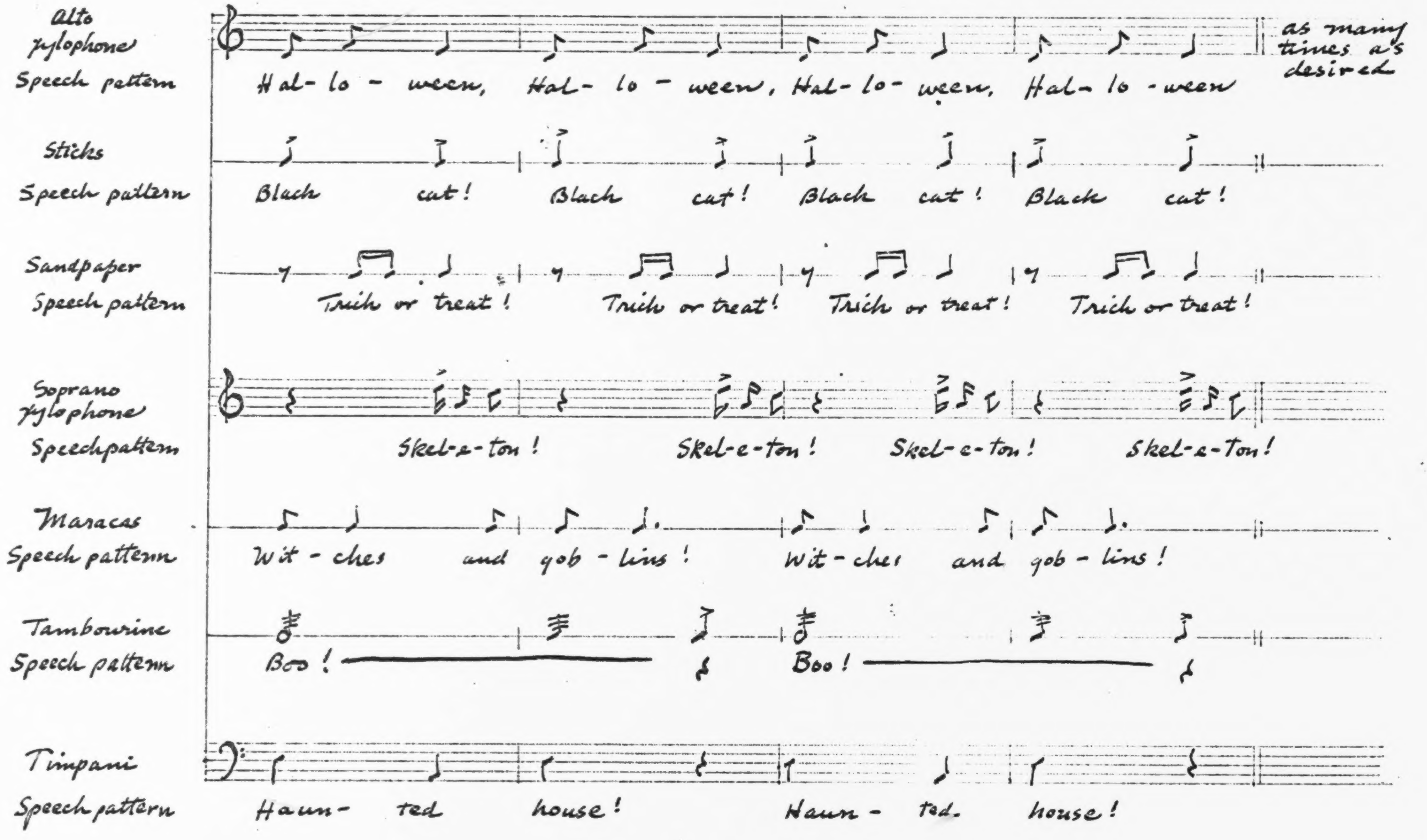
and so on. The children can think of many. We began by putting word combinations together. We did about four sets. Some ingenious children began to use sound effects with the chanting of certain words. For example, on haunted house, one child did a door creaking noise. On witches, another child gave an eerie laugh. And so it went. We concentrated on good pronunciation and diction, and tries many and various ideas.

The song, which we took last, was a culmination of all the things we had tries. The melody was simple, and since we had worked on various word patterns and rhythm patterns, we were able to do the song with relative ease. It was a fun experience.

Halloween Song - Rhythm Patterns

Words and Music by Sister Jeremy Coughlin, S.L.

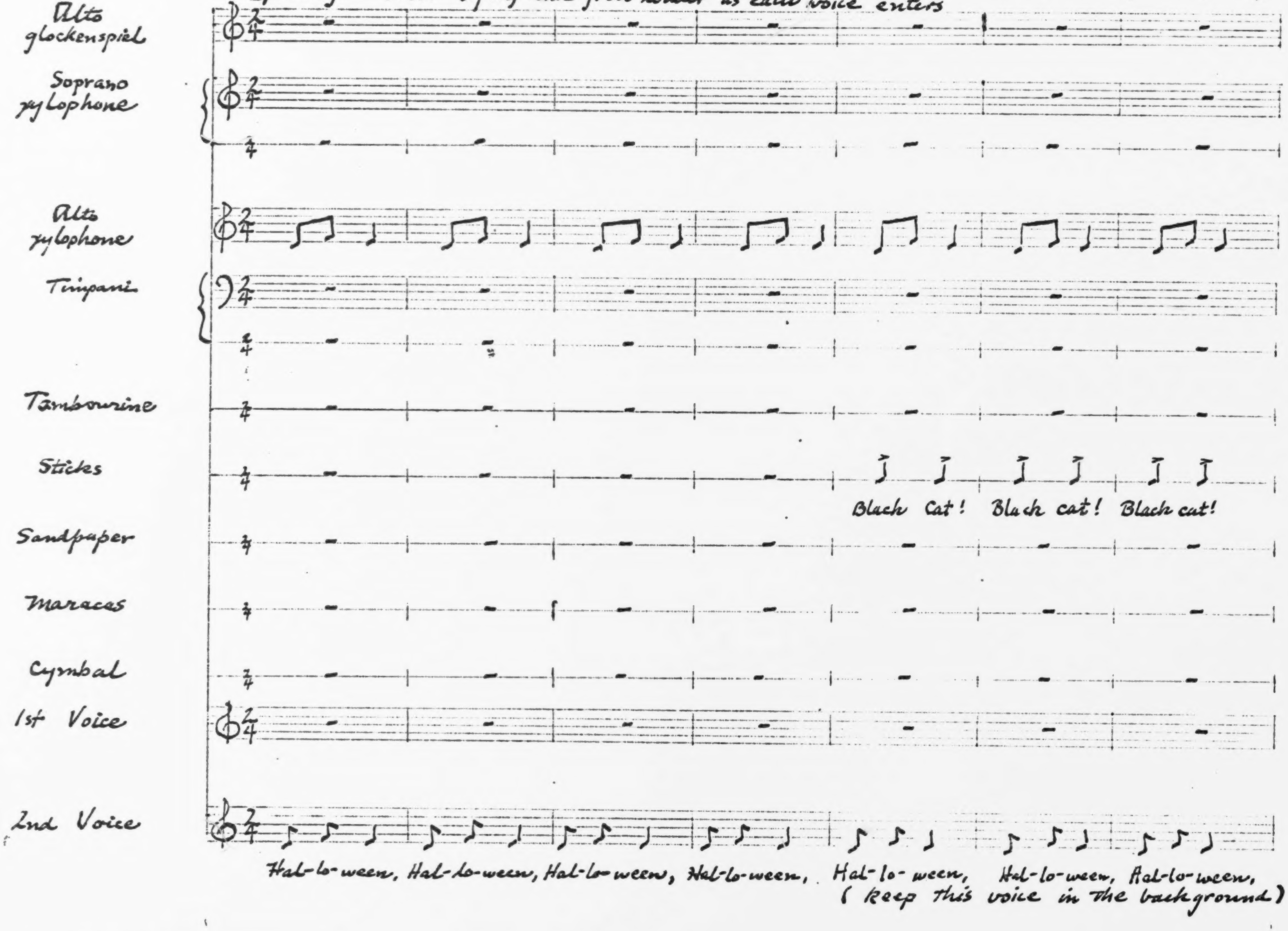
In order of entrance:


Alto xylophone
Speech pattern
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween
as many times as desired
Sticks
Speech pattern
Black cat! Black cat! Black cat! Black cat!
Sandpaper
Speech pattern
Trick or treat! Trick or treat! Trick or treat! Trick or treat!
Soprano xylophone
Speechpattern
Skel-e-ton! Skel-e-ton! Skel-e-ton! Skel-e-Ton!
Maracas
Speech pattern
Wit-ches and gob-lins! Wit-ches and gob-lins!
Tambourine
Speech pattern
Boo! Boo!
Timpani
Speech pattern
Haun-ted house! Haun-ted house!

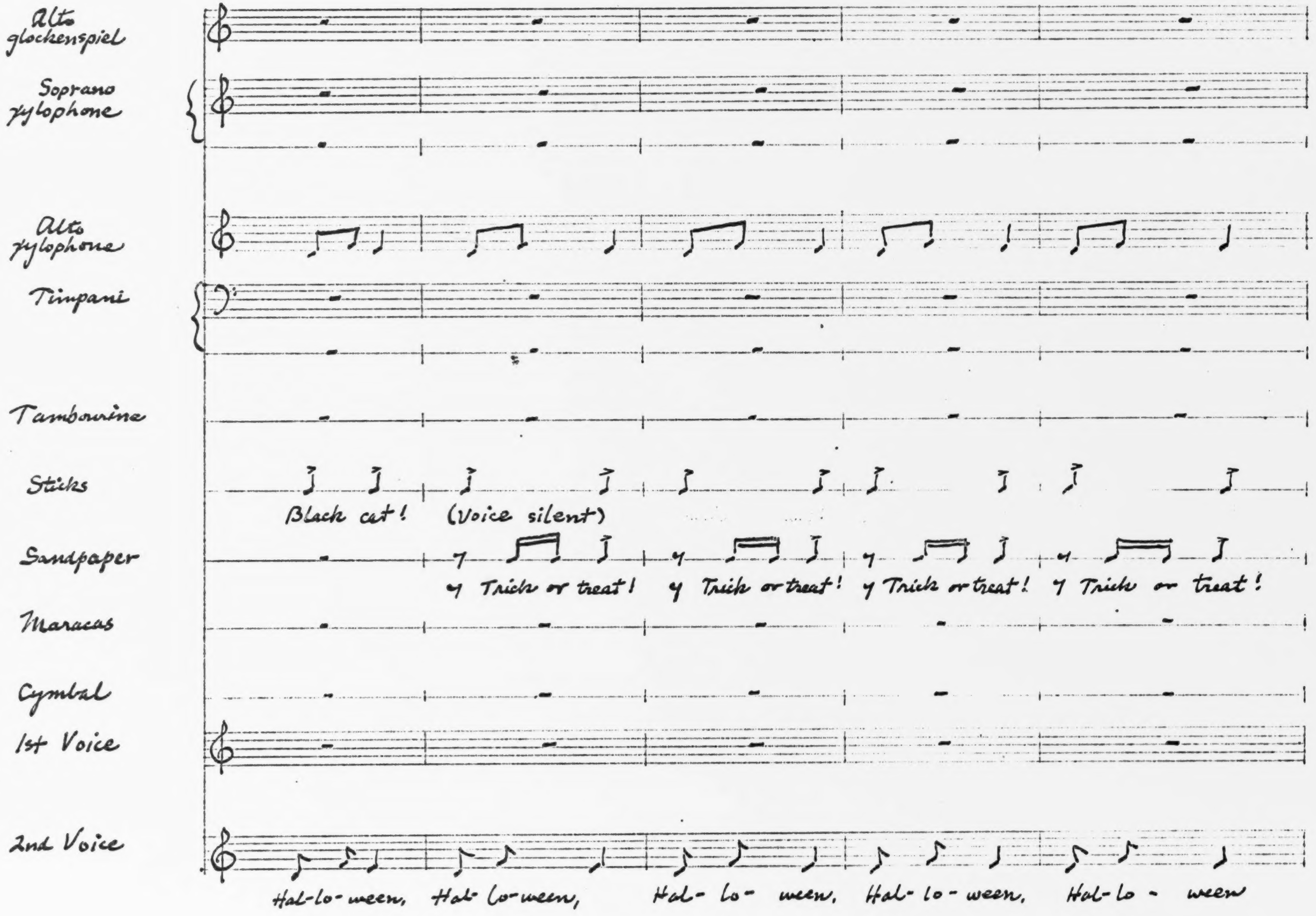
Halloween Song

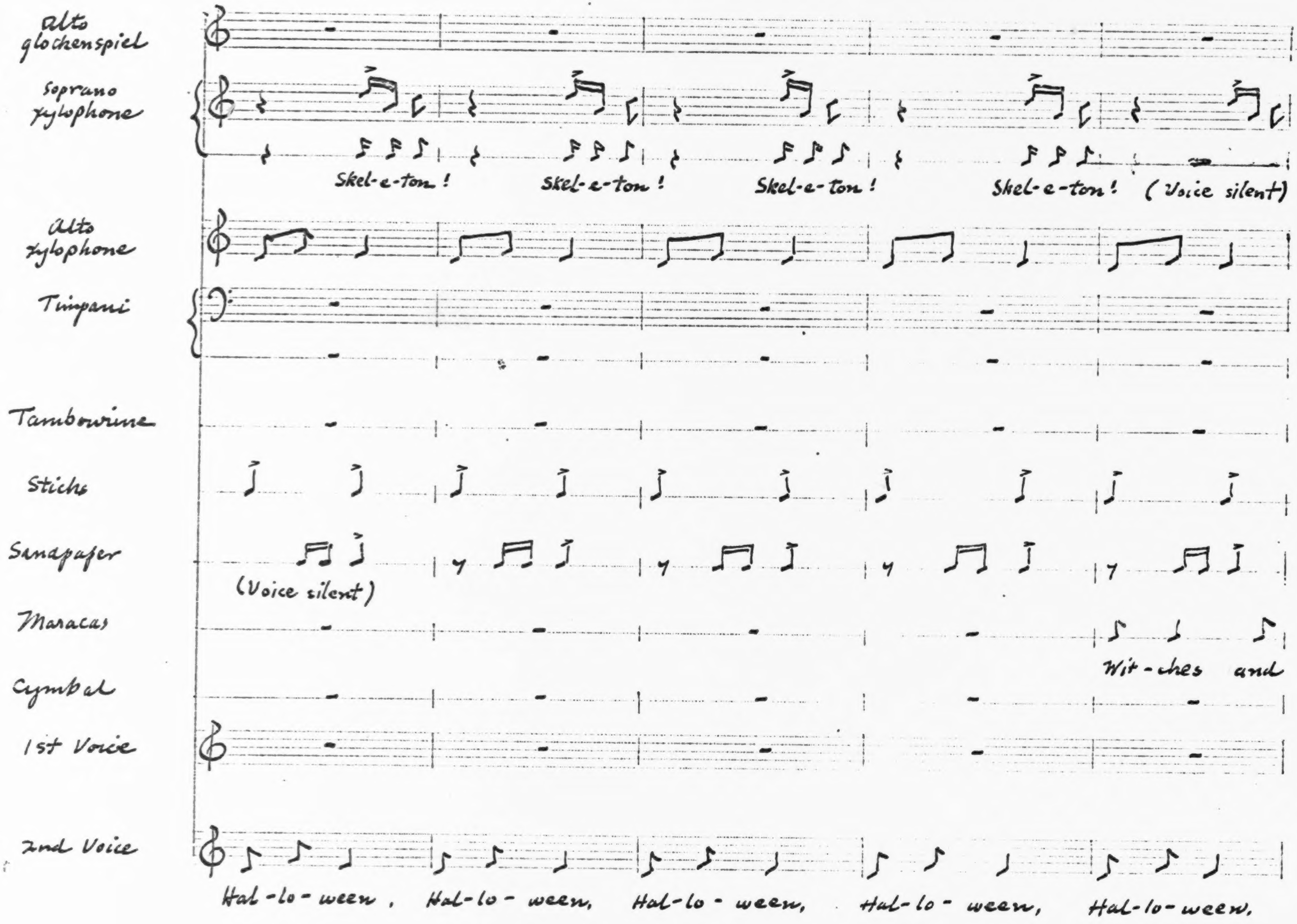
Words and Music by Sister Jeremy Coughlin, S.L.

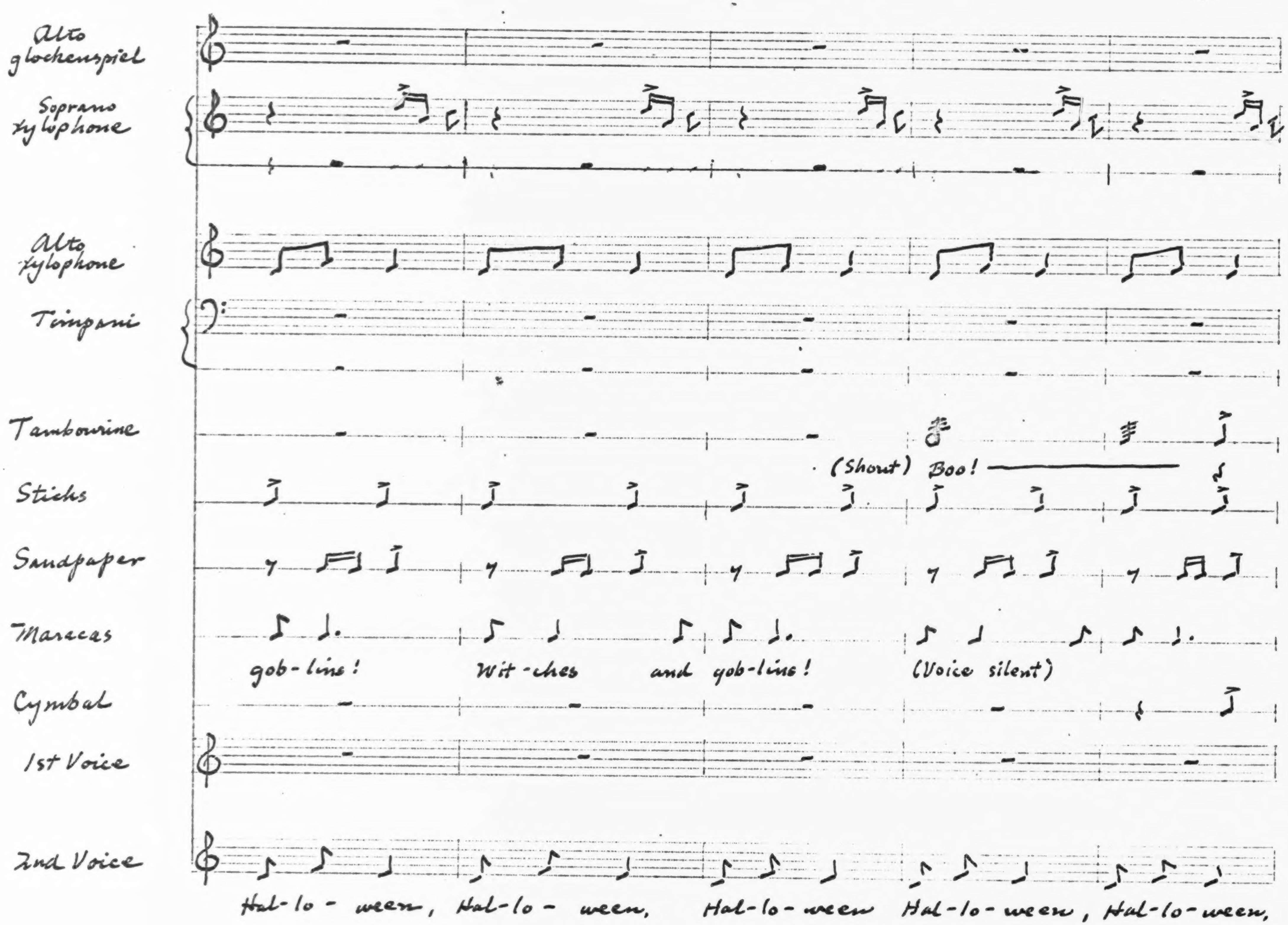
Spooky – Start softly and grow louder as each voice enters

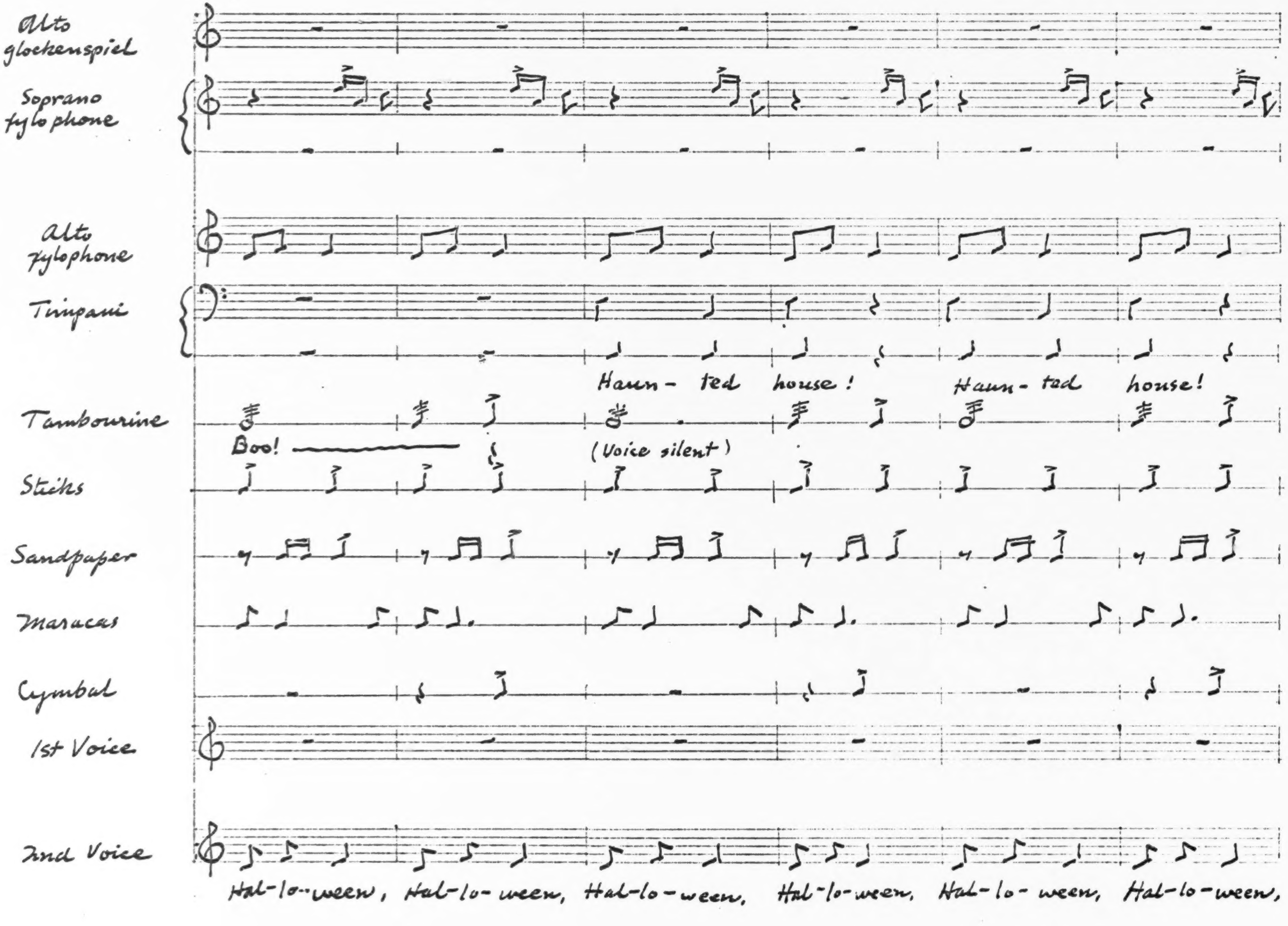

Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Black Cat! Black cat! Black cat!
Sandpaper
Maracas
Cymbal
1st Voice
2nd Voice
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween,
(Keep this voice in the background)

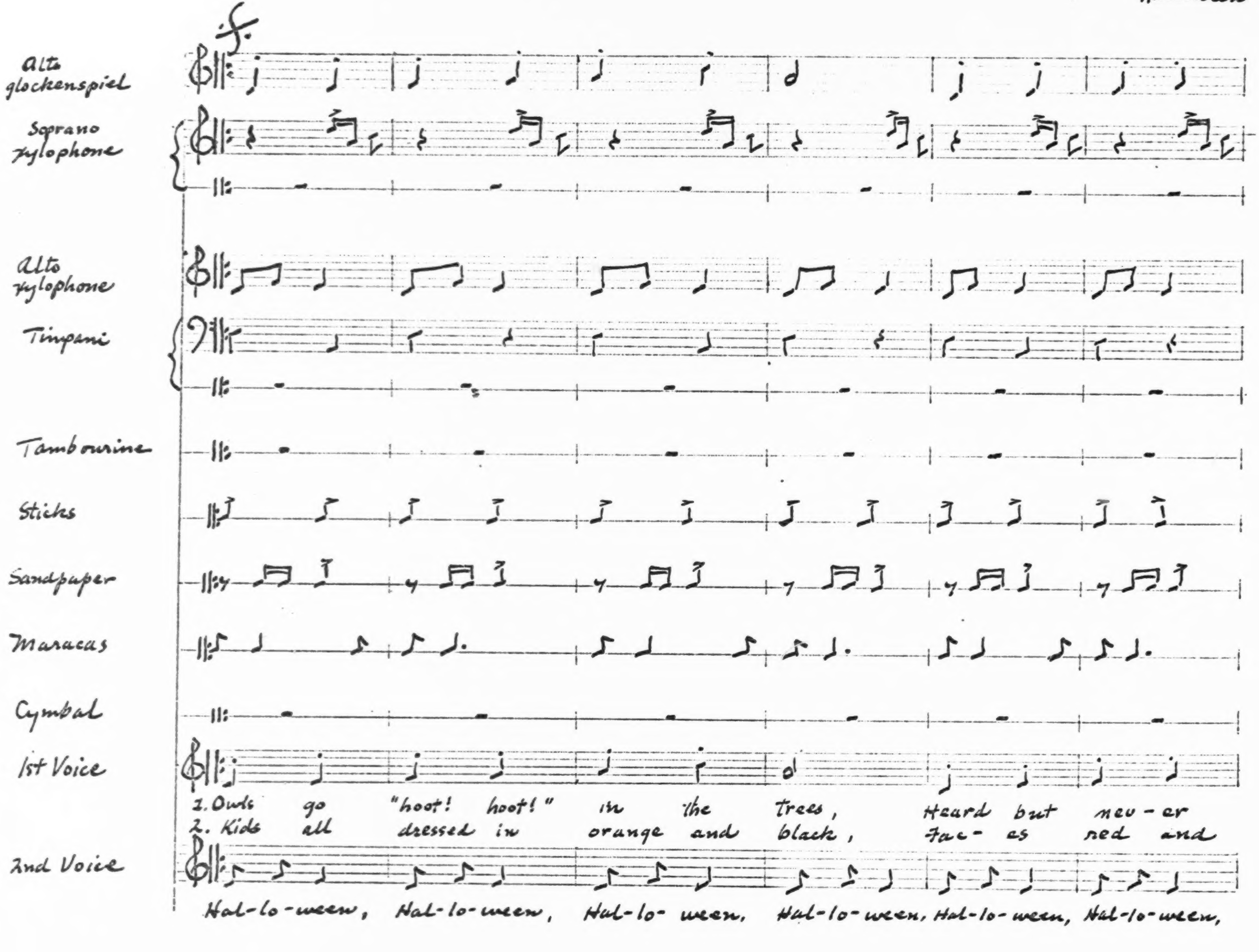
Halloween 2.

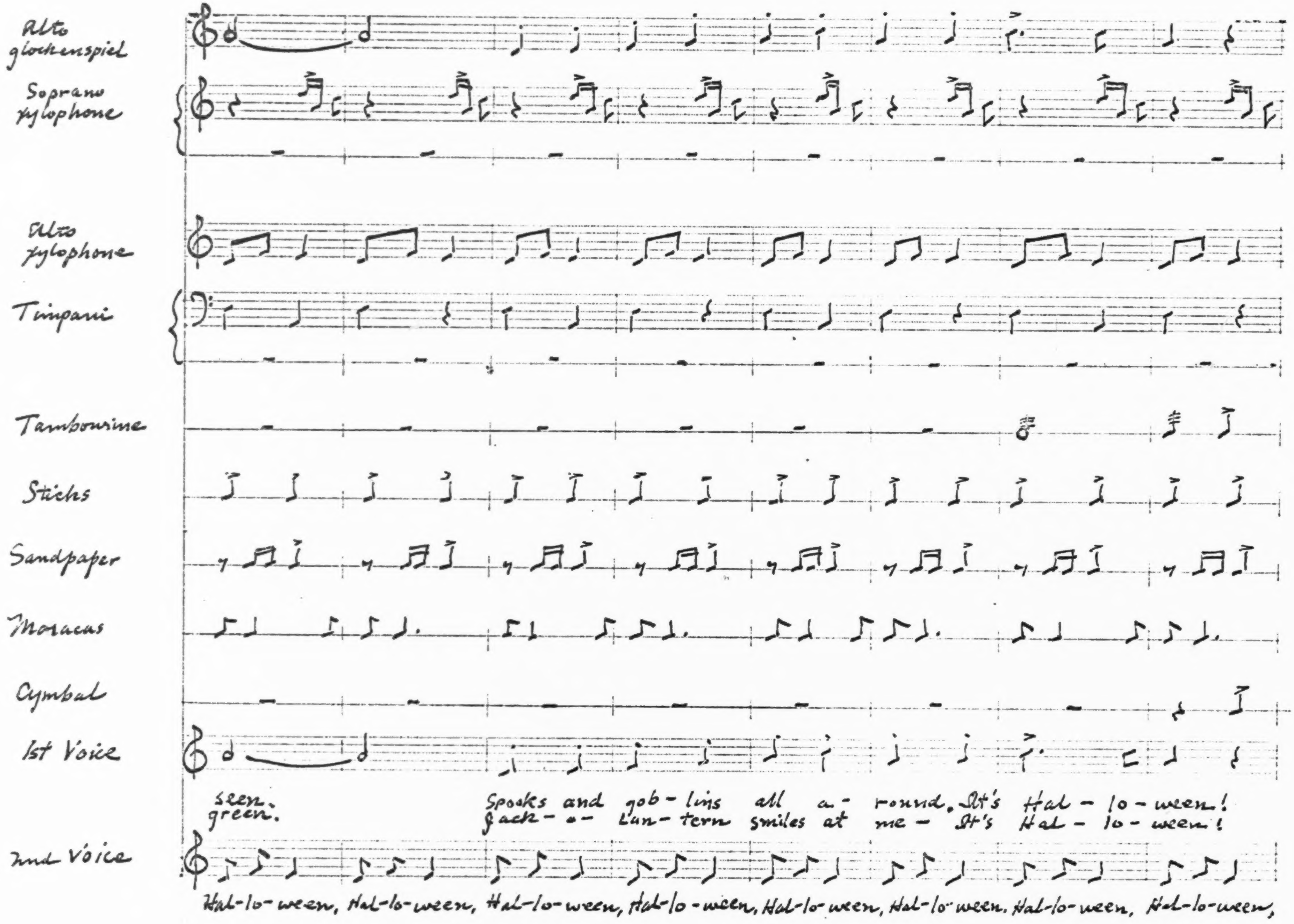

Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Black cat!
(Voice silent)
Sandpaper
Trick or treat! Trick or treat! Trick or treat! Trick or treat!
Maracas
Cymbal
1st Voice
2nd Voice
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween

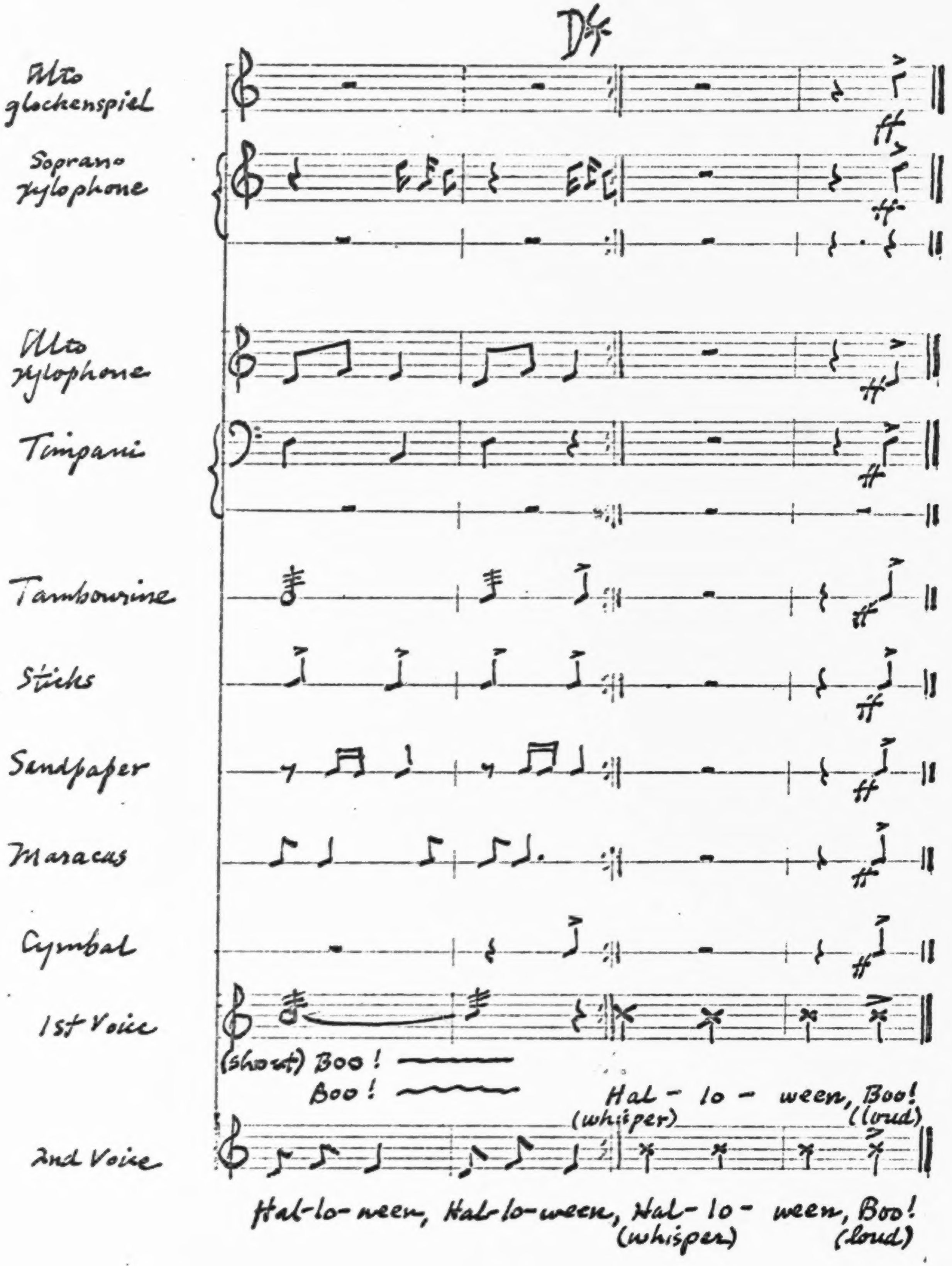

Alto glockenspiel
Soprano xylophone
Skel-e-ton! Skel-e-ton! Skel-e-ton! Skel-e-ton! (Voice silent)
Alto xylophone
Timpani
Tambourine
Sticks
Sandpaper
(Voice silent)
Maracas
Wit-ches and
Cymbal
1st Voice
2nd Voice
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween.


Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Sandpaper
Maracas
Cymbal
1st Voice
2nd Voice
(Shout) Boo!
gob-lins! Wit-ches and gob-lins!
(Voice silent)
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween Hal-lo-ween, Hal-lo-ween,


Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Sandpaper
Maracas
Cymbal
1st Voice
2nd Voice
Haun- ted house! Haun- ted house!
Boo!
(Voice silent)
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween,


Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Sandpaper
Maracas
Cymbal
1st Voice
1. Owls go "hoot! hoot!" in the trees, Heard but nev - er
2. Kids all dressed in orange and black, Fac - es red and
2nd Voice
Hal-lo-ween, Hal-lo-ween, Hal-lo- ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween,


Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Sandpaper
Moracas
Cymbal
1st Voice
seen.
green.
Spooks and gob-lins all a-round. It's Hal-lo-ween!
Jack-o-Lan-tern smiles at me - It's Hal-lo-ween!
2nd Voice
Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween, Hal-lo-ween. Hal-lo-ween, Hal-lo-ween,


D.C.
Alto glockenspiel
Soprano xylophone
Alto xylophone
Timpani
Tambourine
Sticks
Sandpaper
Maracas
Cymbal
1st Voice
(shout) Boo!
Boo!
Hal - lo - ween, Boo!
(whisper)
(loud)
2nd Voice
Hal-lo-ween, Hal-lo-ween, Hal- lo- ween, Boo!
(whisper)
(loud)

VALENTINE DAY

A very nice Valentine program can be made from the various words and ideas used in connection with this day. So often in the past the Valentine box has been the main attraction, and art has usually played a big part in planning for this day. Just as it is more fun to make Valentines than to buy them, so it can be more fun to plan the musical activity than to take songs from a book.

All possible word combinations were used to express the spirit of the day. After trying various groupings of words together, we did the different types of activities with them that the words suggested. So we had:

1. Words and phrases chanted together.
2. Words chanted with percussion instruments.
3. Percussion instruments with a child improvising with a melody instrument.
4. Expressing the words and phrases with body movement.

We then took a song written especially for us and developed it along the same way as we had done our own. The speech patterns included:

1. What shall I buy her?
2. Valentine — sweet heart
3. Love
4. Sh, sh, sh, sh.

With guitar background, we chanted these words in rhythm, after which we went into the singing of the songs. The children improvised the dance they thought went with the music.

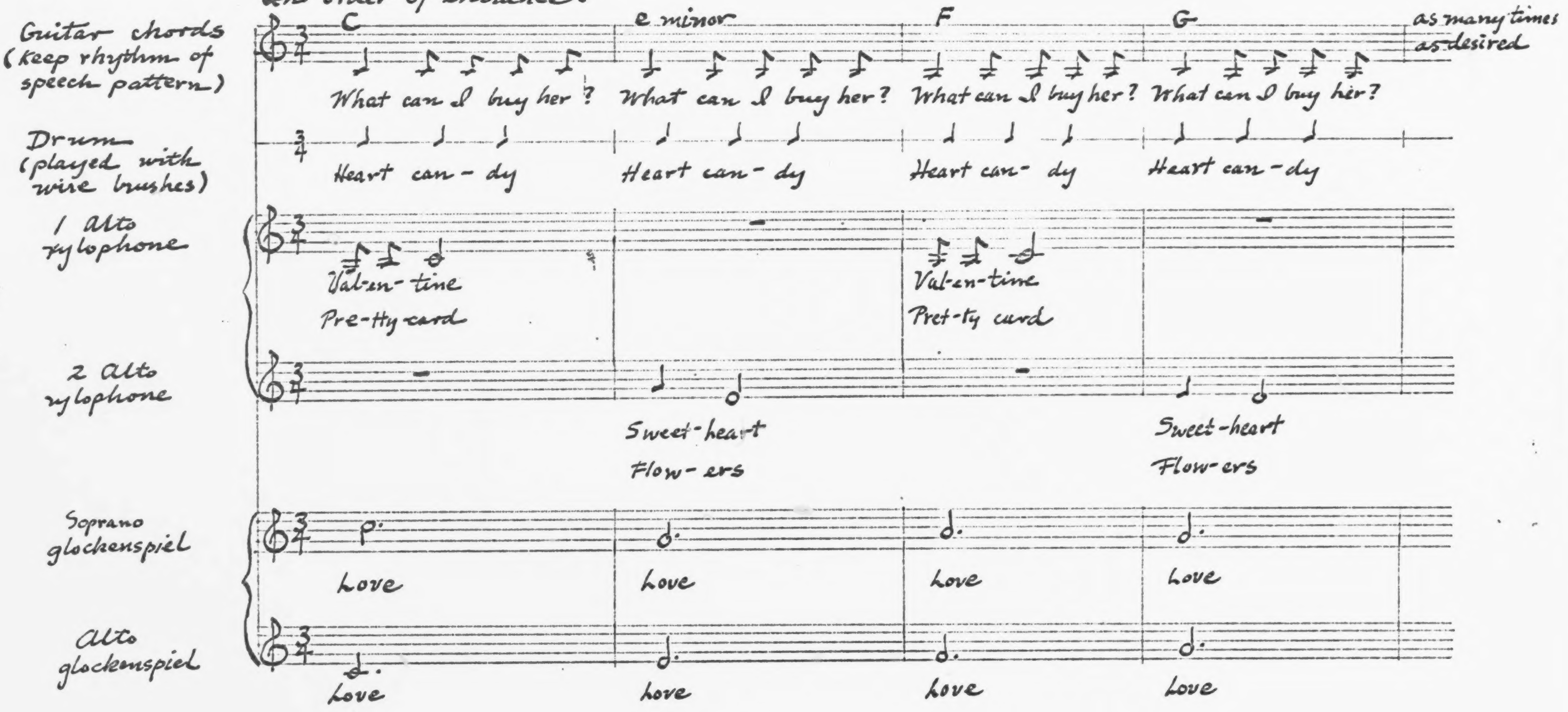
The idea here was to put the music into the present day medium. Speech, rhythm, notation, movement, instruments, vocal work, all played an interesting part.

During the speech work, the lips, tongue, timbre, were consciously used to produce good diction, the right sound, and the correct interpretation. The different rhythms were clapped, written on the staff, played on percussion instruments, and danced. The finished product was an experience rather than a song.

Valentine Song - Rhythm Patterns

Words and music by Sister Jeremy Coughlin, S.L.

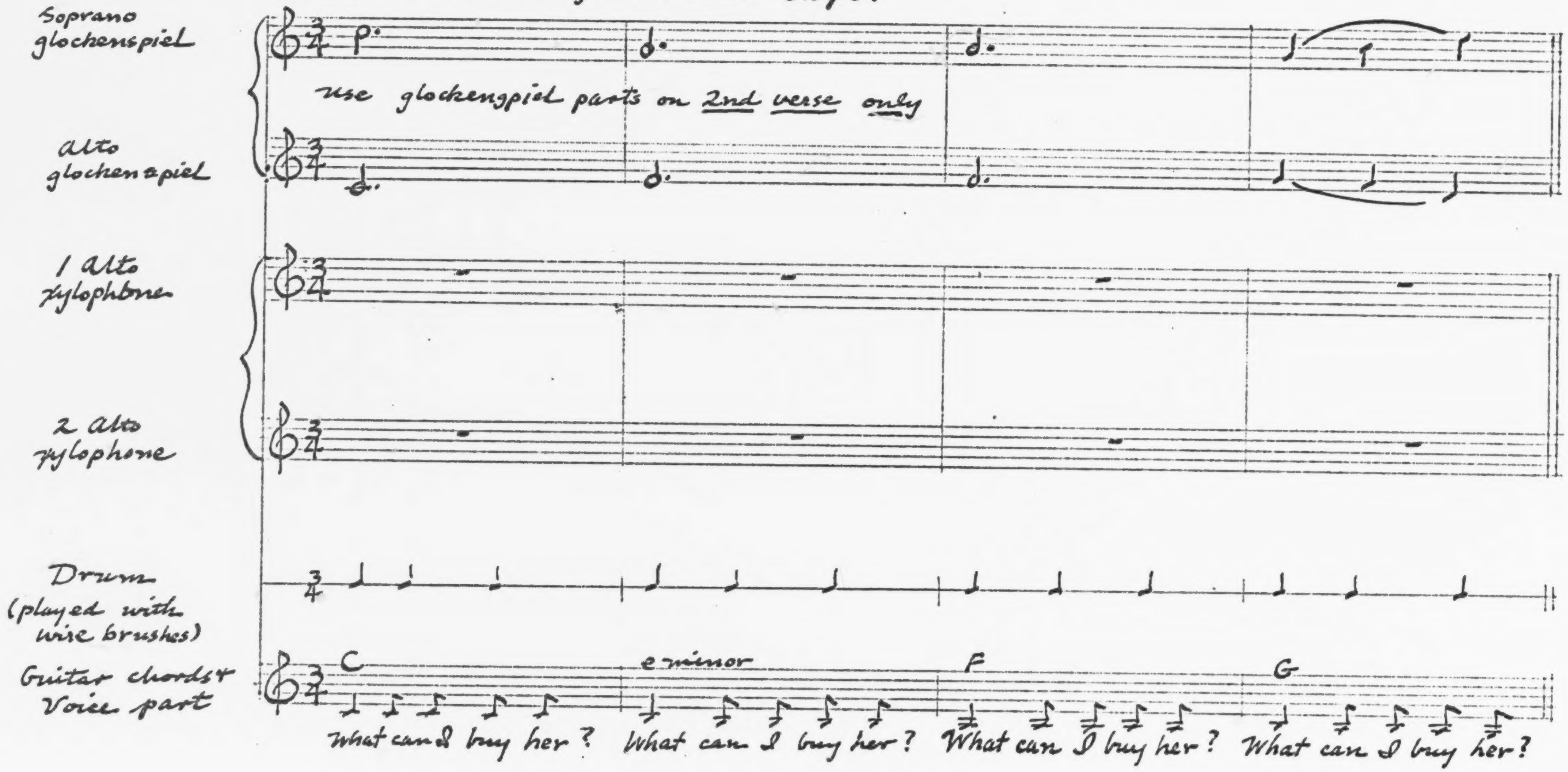
In order of entrance:

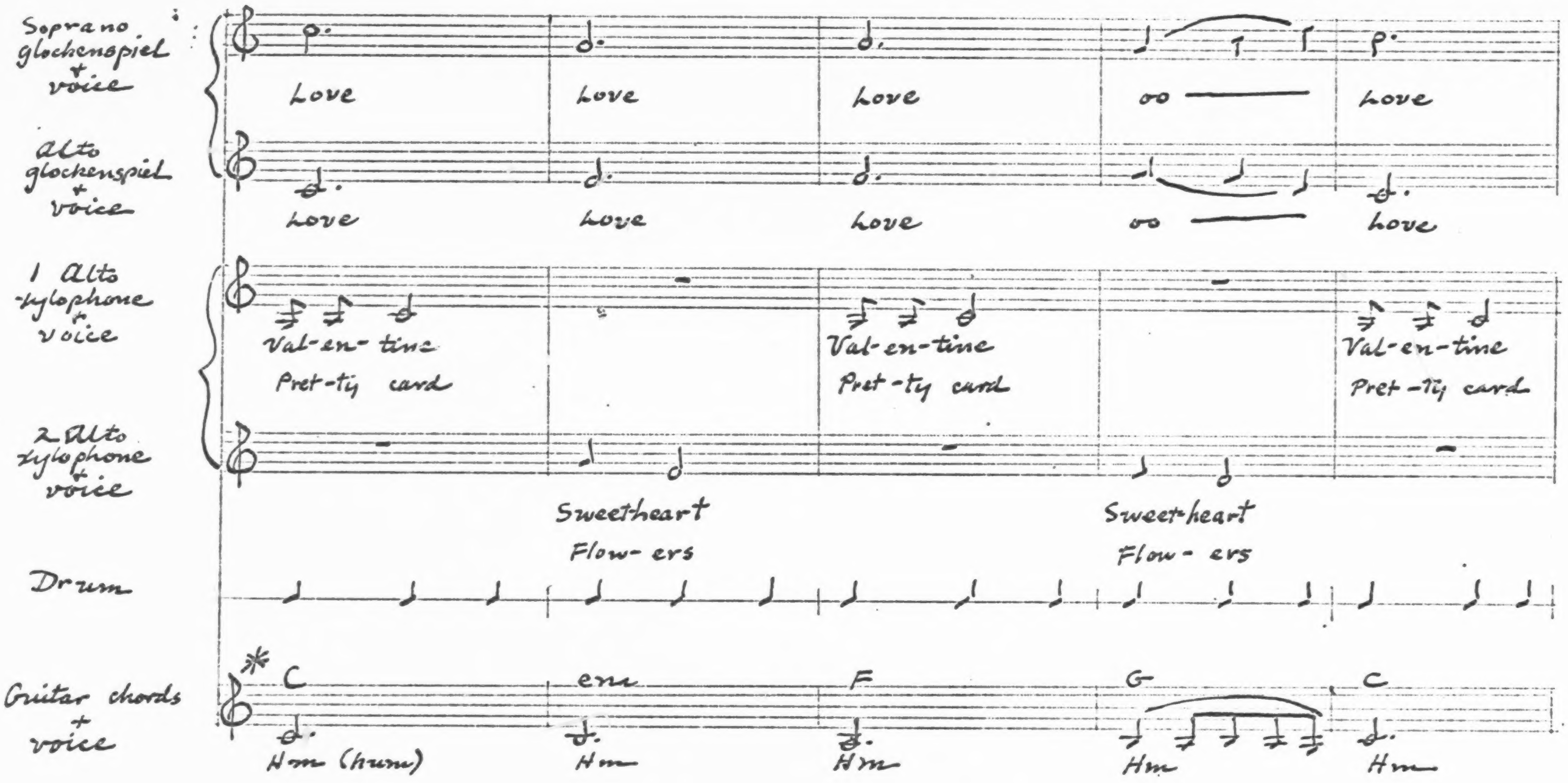

Guitar chords (keep rhythm of speech pattern)
C
e minor
F
G
as many times as desired
What can I buy her? What can I buy her? What can I buy her? What can I buy her?
Drum (played with wire brushes)
Heart can-dy Heart can-dy Heart can-dy Heart can-dy
1 Alto xylophone
Val-en-tine
Pre-tty card
Val-en-tine
Pret-ty card
2 Alto xylophone
Sweet-heart
Flow-ers
Sweet-heart
Flow-ers
Soprano glockenspiel
Love Love Love Love
Alto glockenspiel
Love Love Love Love

Valentine Song

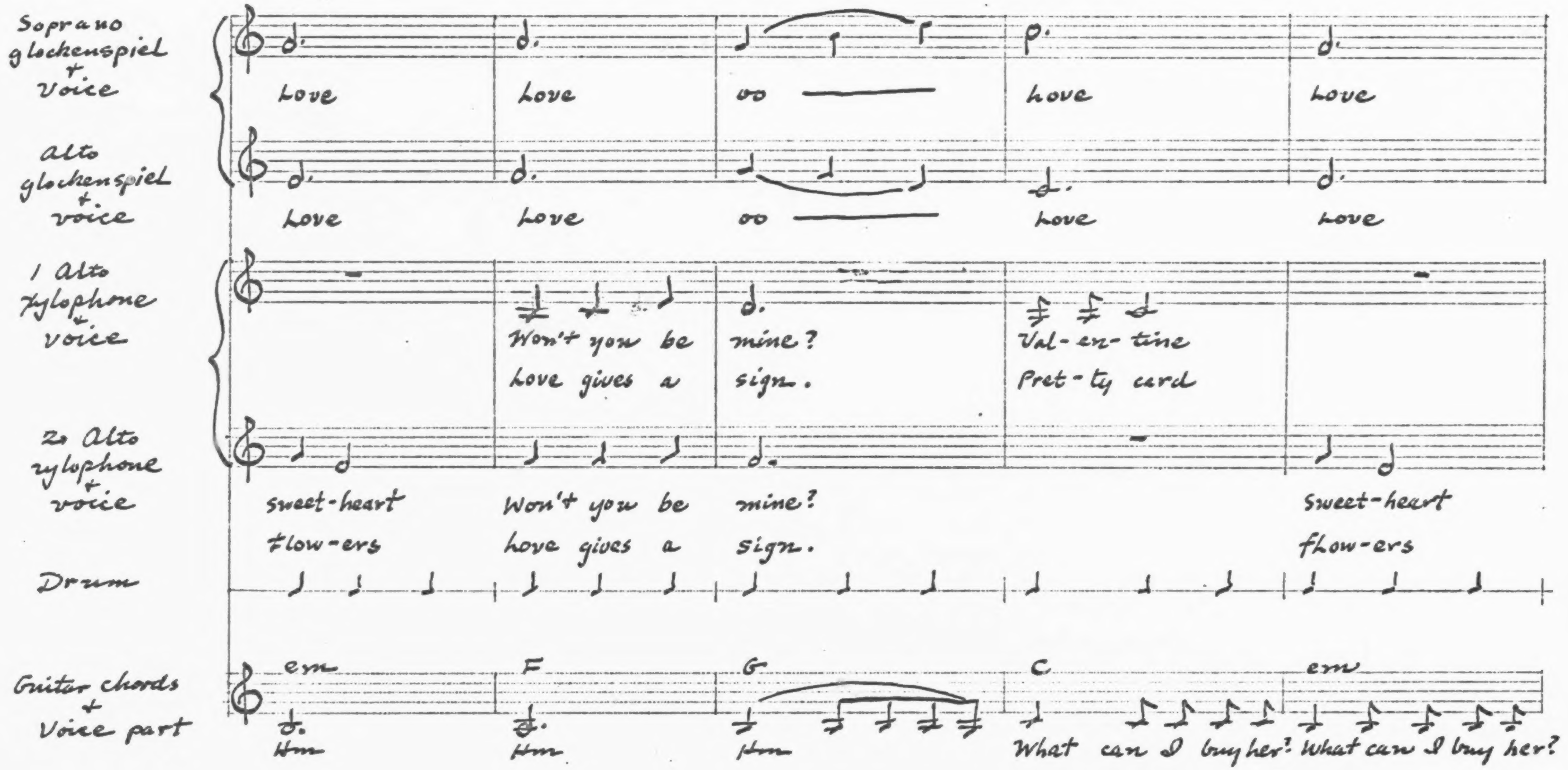
Words and Music by Sister Jeremy Coughlin, S.L.

Smooth – a love song. Moderate tempo.

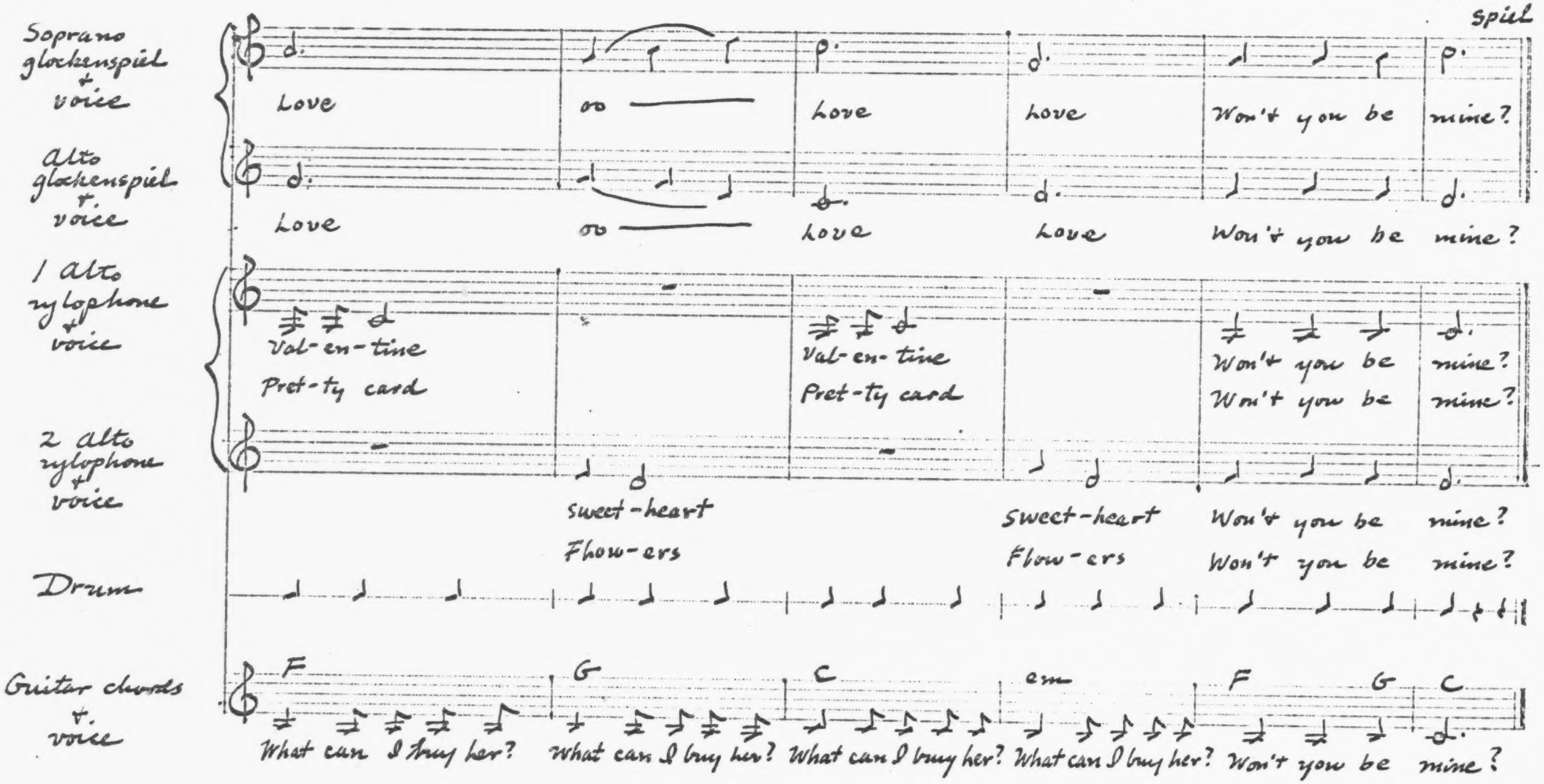

Soprano glockenspiel
use glockenspiel parts on 2nd verse only
alto glockenspiel
1 alto xylophone
2 alto xylophone
Drum (played with wire brushes)
Guitar chords & Voice part
C
e minor
F
G
What can I buy her? What can I buy her? What can I buy her? What can I buy her?


Soprano glockenspiel + voice
Love
Love
Love
oo
Love
Alto glockenspiel + voice
Love
Love
Love
oo
Love
1 Alto xylophone + voice
Val-en-tine
Pret-ty card
Val-en-tine
Pret-ty card
Val-en-tine
Pret-ty card
2 Alto xylophone + voice
Sweetheart
Flow-ers
Sweet-heart
Flow-ers
Drum
Guitar chords + voice
*
C
em
F
G
C
Hm (hum)
Hm
Hm
Hm
Hm

* Guitar accompaniment keeps the same rhythm as the beginning: ♩ ♫♫ etc.


Soprano glockenspiel + Voice
Alto glockenspiel + voice
1 Alto Xylophone + voice
2 Alto xylophone + voice
Drum
Guitar chords + Voice part
Love Love oo Love Love
Love Love oo Love Love
Won't you be mine? Val-en-tine
Love gives a sign. Pret-ty card
sweet-heart Won't you be mine? Sweet-heart
flow-ers Love gives a sign. flow-ers
em F G C em
Hm Hm Hm What can I buy her? What can I buy her?

Valentine 4.


Soprano glockenspiel + voice
Alto glockenspiel + voice
1 Alto xylophone + voice
2 Alto xylophone + voice
Drum
Guitar chords + voice
Love
oo
Love
Love
Won't you be mine?
Love
oo
Love
Love
Won't you be mine?
Val-en-tine
Pret-ty card
Val-en-tine
Pret-ty card
Won't you be mine?
Won't you be mine?
Sweet-heart
Flow-ers
Sweet-heart
Flow-ers
Won't you be mine?
Won't you be mine?
F
G
C
em
F
G
C
What can I buy her? What can I buy her? What can I buy her? What can I buy her? Won't you be mine?

D.C. add glocken
spiel + voice o
2nd vers

EASTER

Easter was the third and last holiday we did this year. Next year we hope to add others.

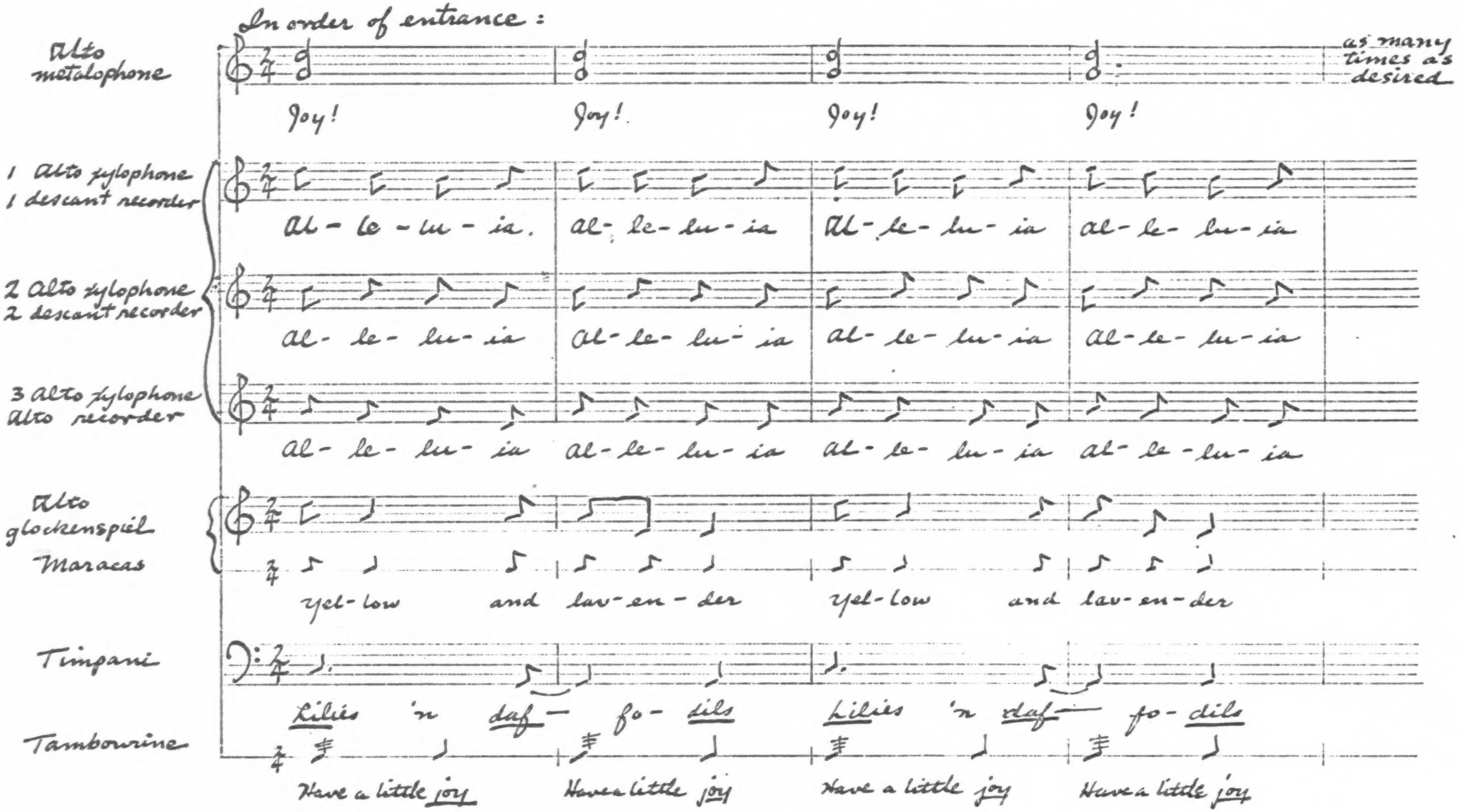
The spirit of Easter is certainly unlike that of either Halloween or Valentine Day, so we had to approach it differently. We discussed the Easter spirit and its meaning. We tried out instruments that seemed to express this spirit. We worked out movements that were more "spiritualized" than those of Halloween or Valentine Day. It is fun to contrast and Alleluia with Witches and Goblins. By using contrasts, the children arrive at better understanding of kinds of movements. This idea of contrast is successfully used with instruments and voice expression also.

We learned this song in sections. The three part Alleluia was played on instruments first. Then, the dancing is interesting because each part has the same descending pattern and so makes a nice high, middle, and lower grouping idea work nicely. The singing is not difficult after having done the playing and dancing. The unison part provided a nice contrast within the song and since we had already worked on contrasts, it was easy to transfer and get some creative work that might have been more difficult without the background we had built up.

To approach a song from many different points gives new impetus to the music period. They are learning without being bored and challenged without being pushed.

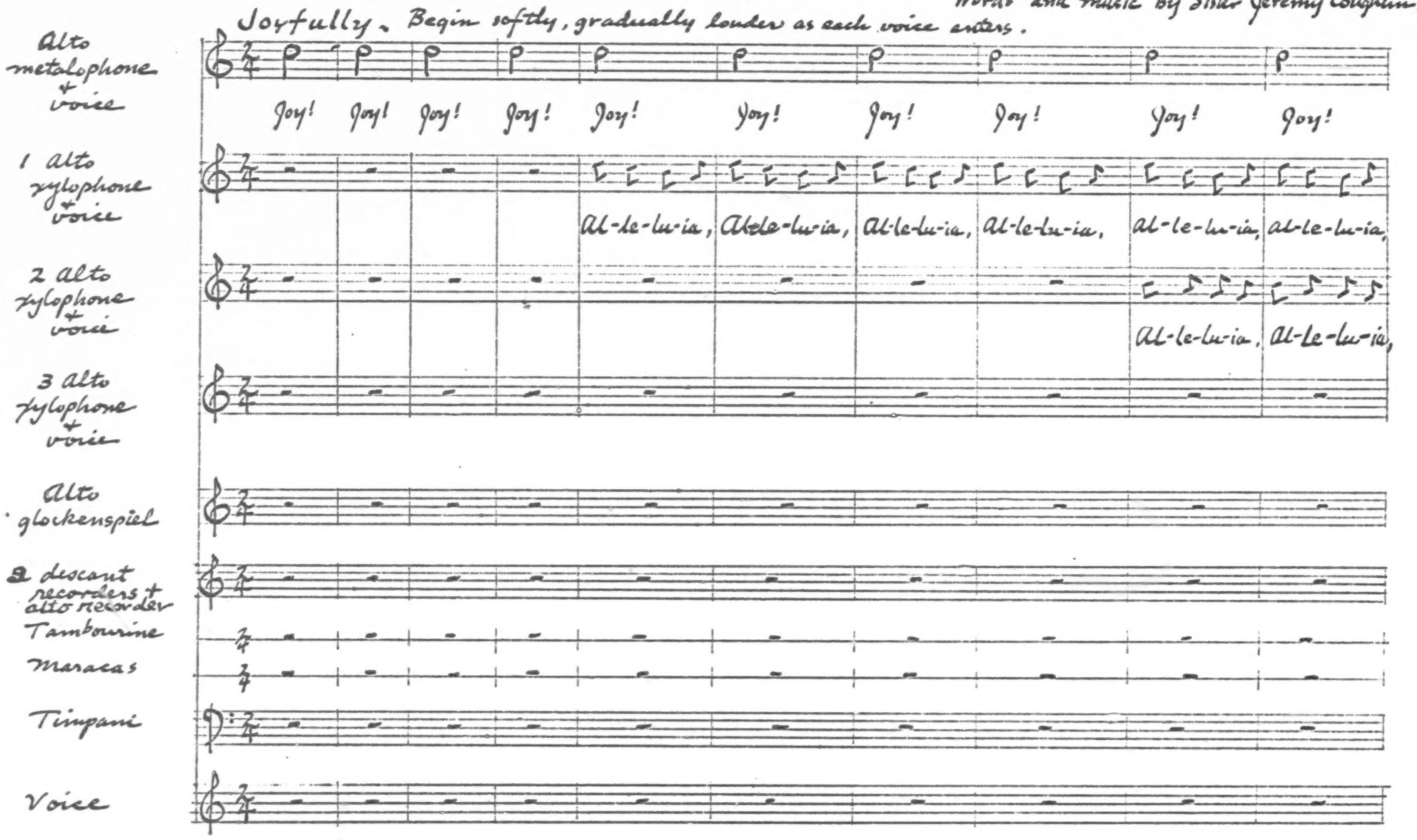
Easter Song - Rhythm Patterns

Words and music by Sister Jeremy Coughlin, S.L.

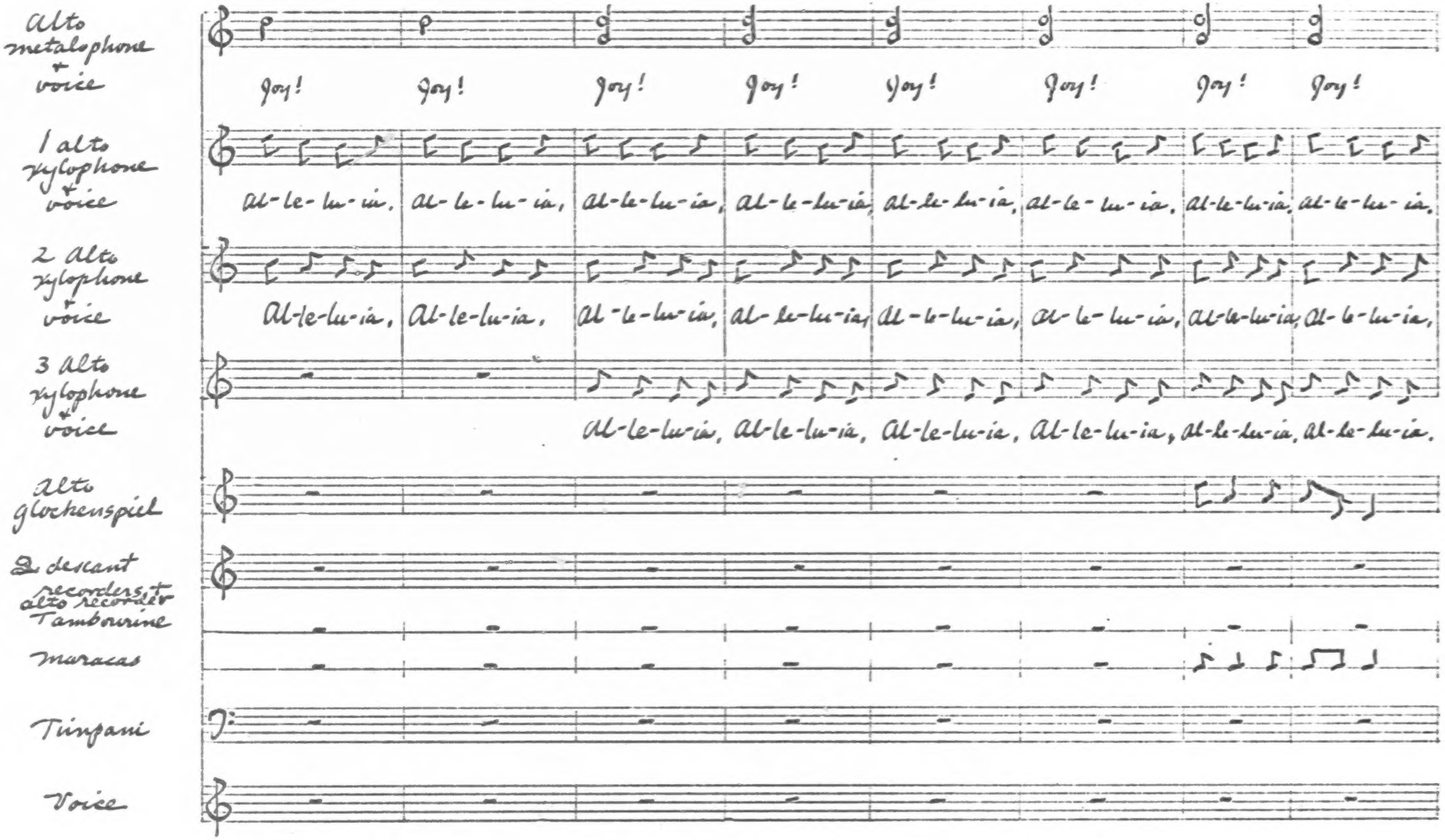

In order of entrance:
Alto metalophone
Joy! Joy! Joy! Joy!
as many times as desired
1 Alto xylophone
1 descant recorder
Al-le-lu-ia. Al-le-lu-ia Al-le-lu-ia Al-le-lu-ia
2 Alto xylophone
2 descant recorder
Al-le-lu-ia Al-le-lu-ia Al-le-lu-ia Al-le-lu-ia
3 Alto xylophone
Alto recorder
Al-le-lu-ia Al-le-lu-ia Al-le-lu-ia Al-le-lu-ia
Alto glockenspiel
Maracas
yel-low and lav-en-der yel-low and lav-en-der
Timpani
Lilies 'n daf-fo-dils Lilies 'n daf-fo-dils
Tambourine
Have a little joy Have a little joy Have a little joy Have a little joy

Easter Song

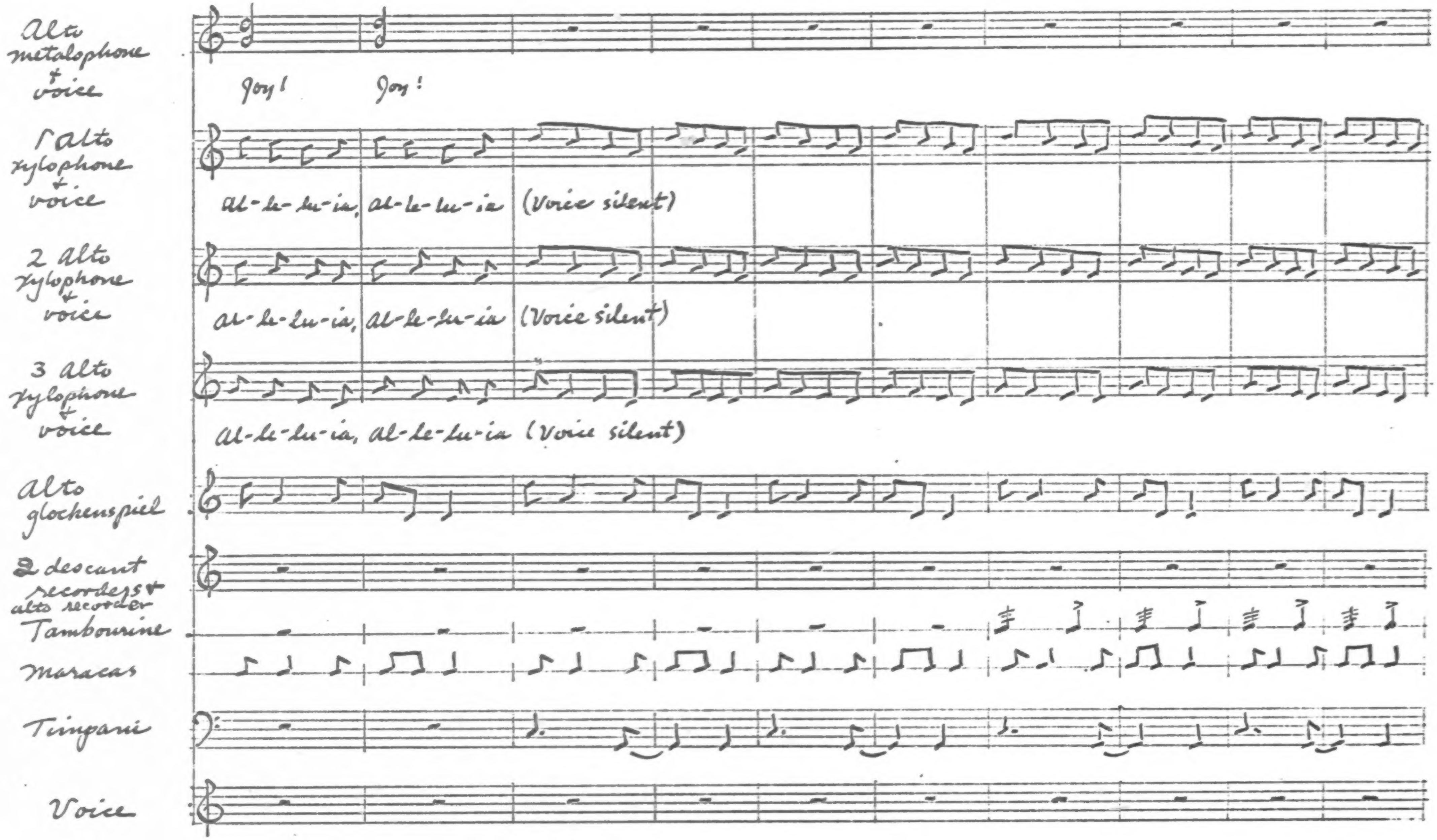
Words and music by Sister Jeremy Coughlin, S.L.


Joyfully. Begin softly, gradually louder as each voice enters.
Alto metalophone + voice
Joy! Joy! Joy! Joy! Joy! Joy! Joy! Joy! Joy! Joy!
1 alto xylophone + voice
Al-le-lu-ia, Alele-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia,
2 alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia,
3 alto xylophone + voice
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice

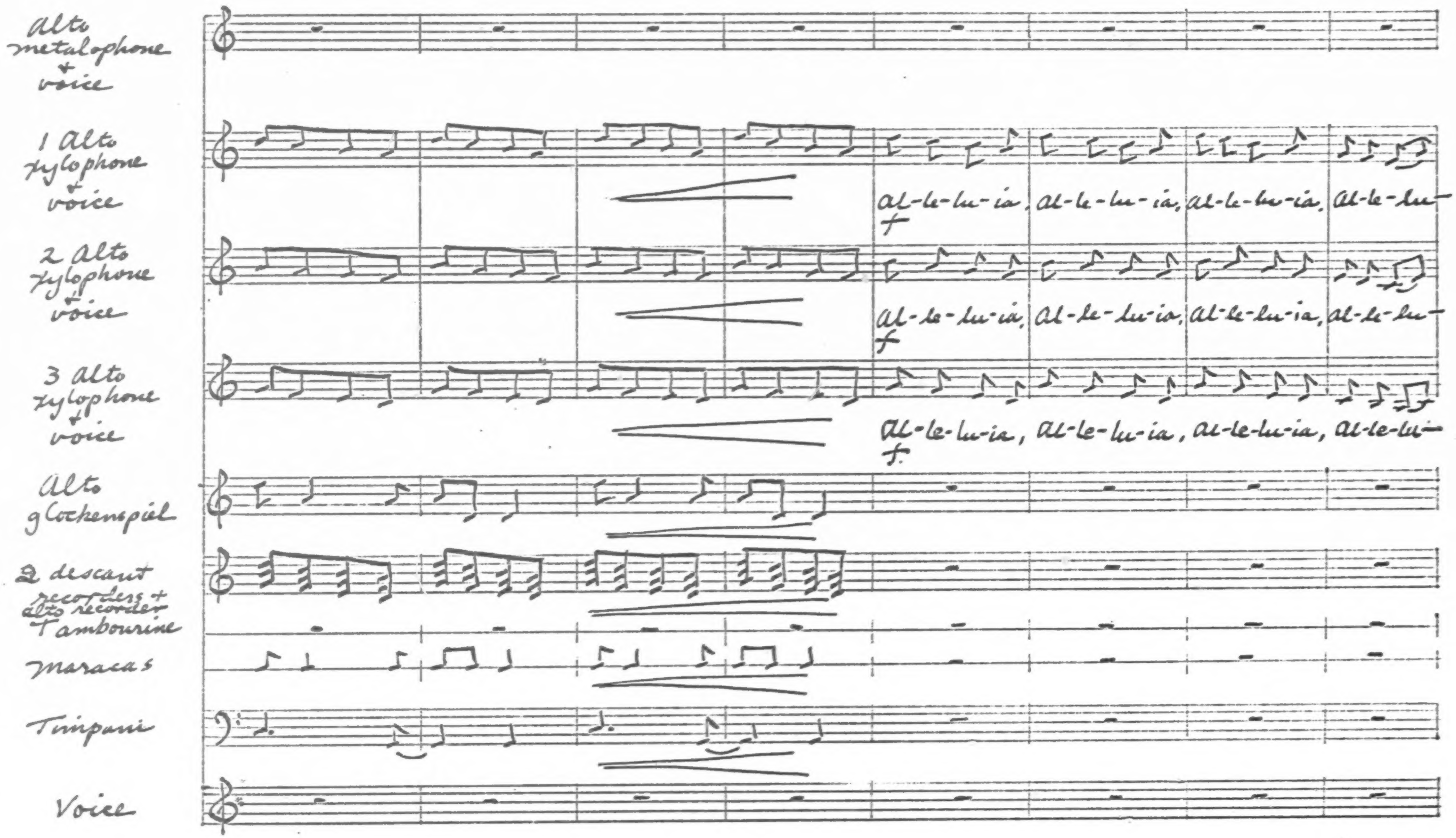
Easter 2.

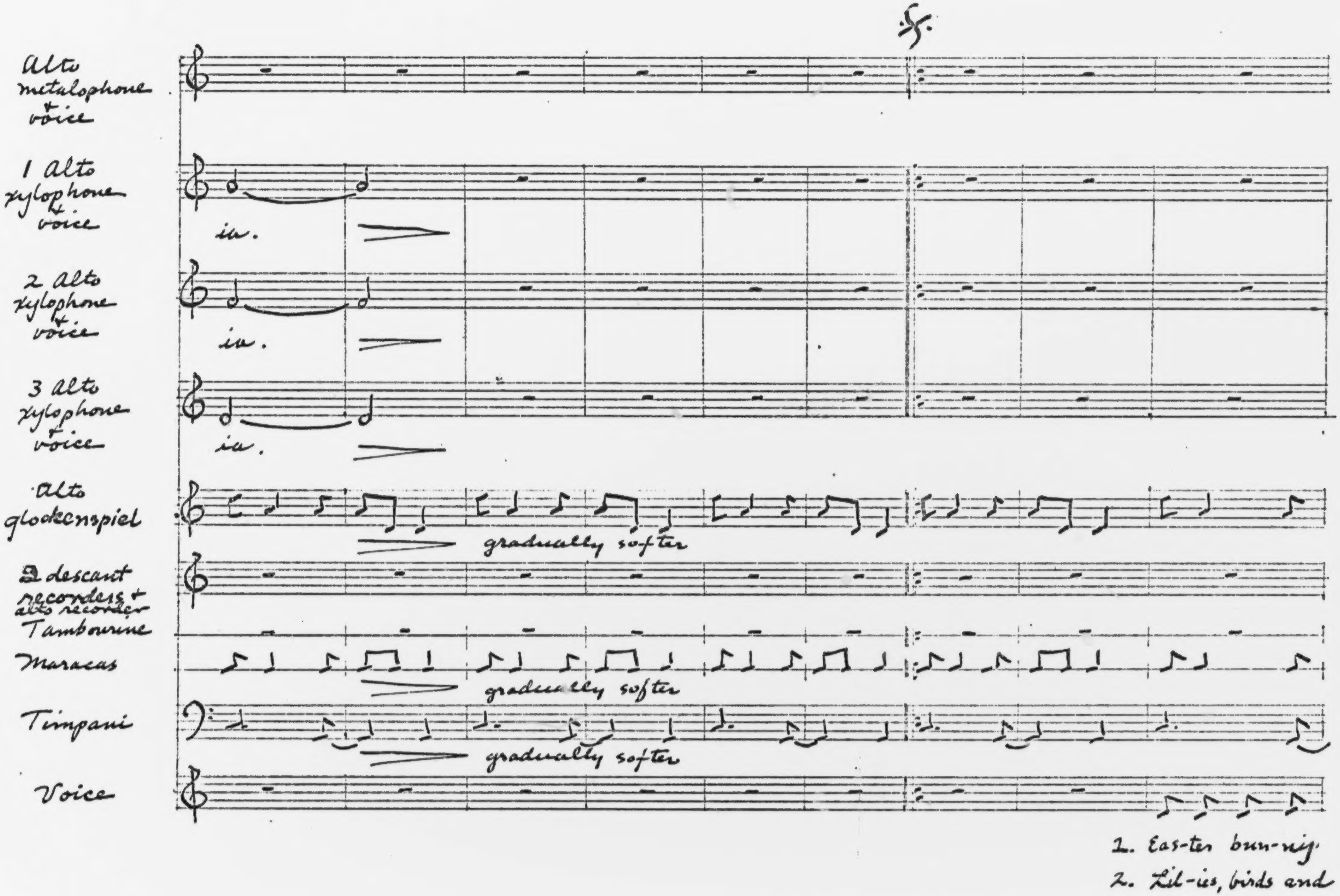

Alto metalophone + voice
Joy! Joy! Joy! Joy! Joy! Joy! Joy! Joy!
1 alto xylophone + voice
Al-le-lu-ia. Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia,
2 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia,
3 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia.
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice

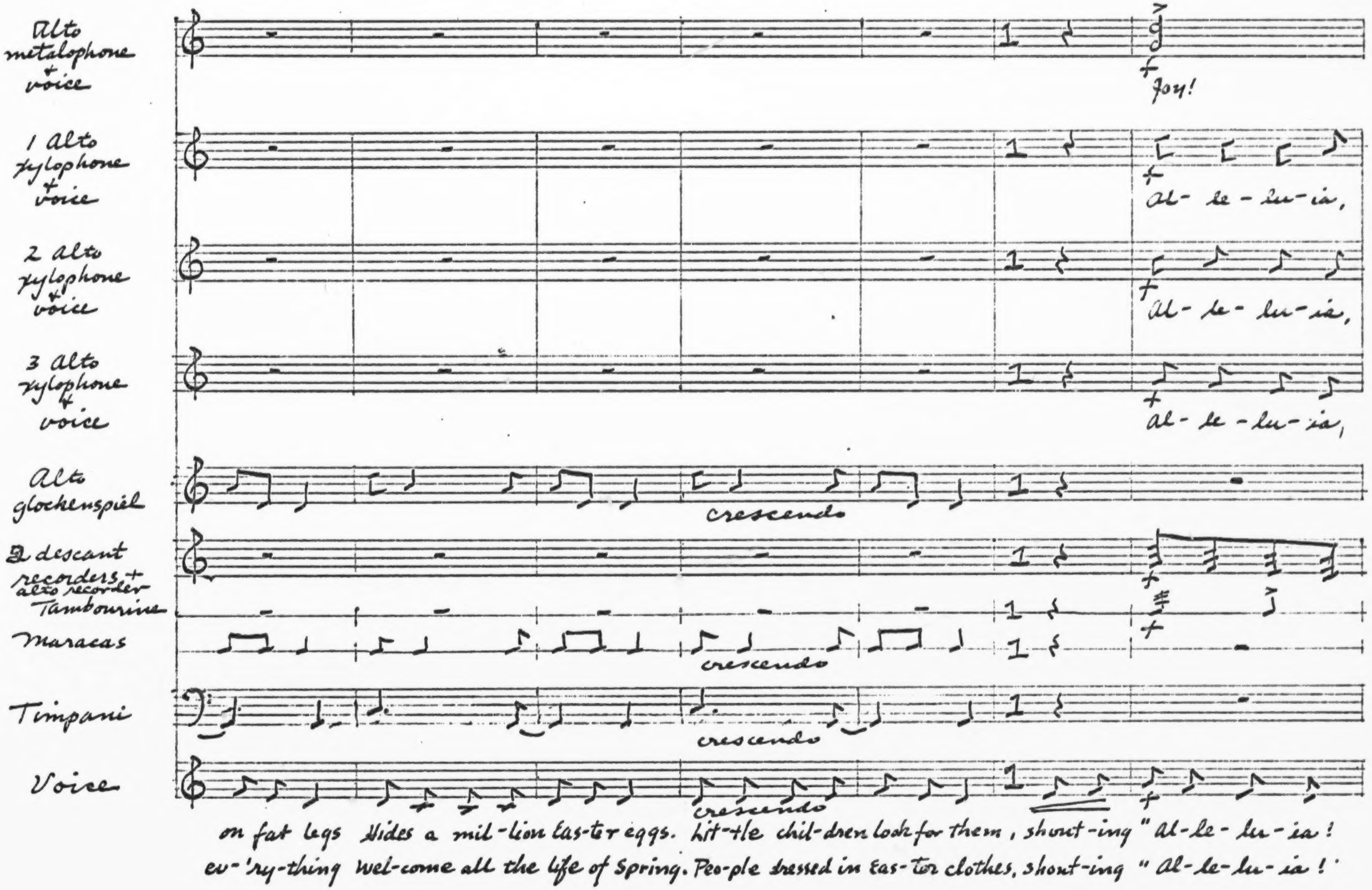
Easter 3.

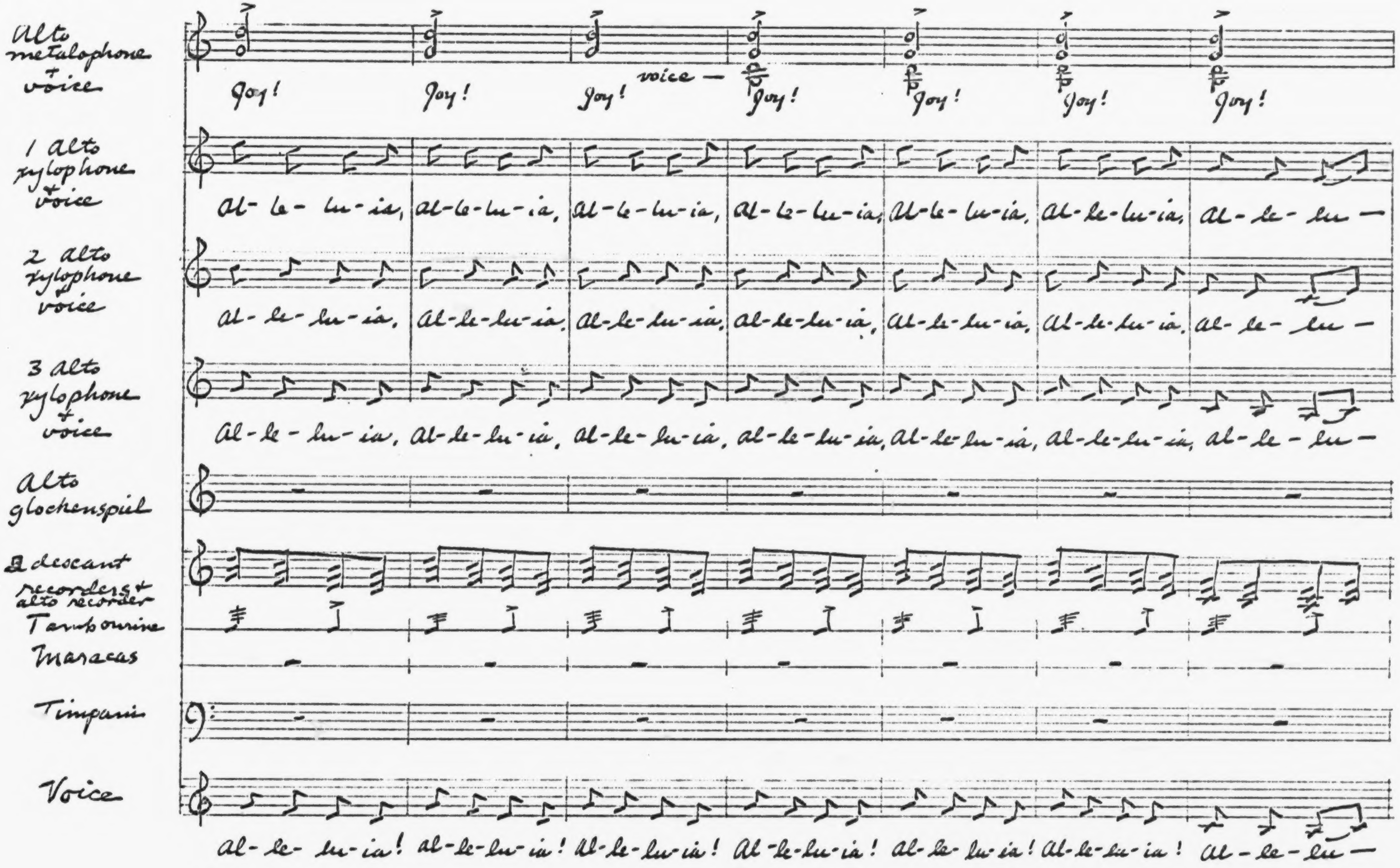

Alto metalophone + voice
Joy! Joy!
1 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia (Voice silent)
2 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia (Voice silent)
3 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia (Voice silent)
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice

Easter 4.

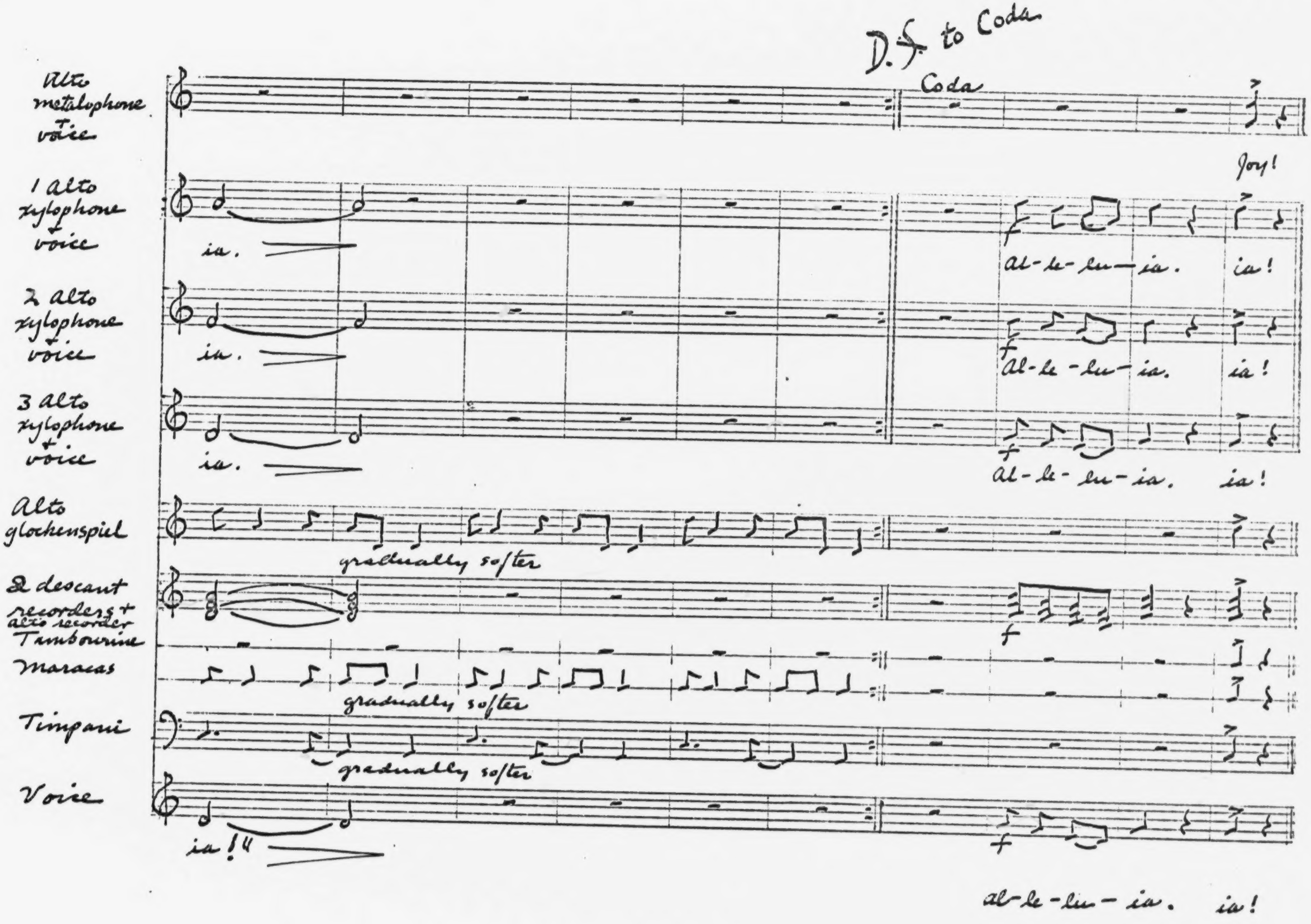

Alto metalophone + voice
1 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-
f
2 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-
f
3 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-
f
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice


Alto metalophone + voice
1 Alto xylophone + voice
2 Alto xylophone + voice
3 Alto xylophone + voice
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice
𝄋
ia.
ia.
ia.
gradually softer
gradually softer
gradually softer
1. Eas-ter bun-nies,
2. Lil-ies, birds and


Alto metalophone + voice
Joy!
1 Alto xylophone + voice
Al- le - lu - ia,
2 Alto xylophone + voice
Al- le - lu - ia,
3 Alto xylophone + voice
Al- le - lu - ia,
Alto glockenspiel
crescendo
2 descant recorders + alto recorder
Tambourine
Maracas
crescendo
Timpani
crescendo
Voice
crescendo
f
on fat legs Hides a mil-lion Eas-ter eggs. Lit-tle chil-dren look for them, shout-ing "Al-le-lu-ia!
ev-'ry-thing Wel-come all the life of Spring. Peo-ple dressed in Eas-ter clothes, shout-ing "Al-le-lu-ia!"


Alto metalophone + voice
Joy! Joy! Joy! voice — Joy! Joy! Joy! Joy!
1 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu —
2 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu —
3 Alto xylophone + voice
Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu-ia, Al-le-lu —
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice
Al-le-lu-ia! Al-le-lu-ia! Al-le-lu-ia! Al-le-lu-ia! Al-le-lu-ia! Al-le-lu-ia! Al-le-lu —

(same as verse 1)


D.S. to Coda
Coda
Alto metalophone + voice
1 Alto xylophone + voice
2 Alto xylophone + voice
3 Alto xylophone + voice
Alto glockenspiel
2 descant recorders + alto recorder
Tambourine
Maracas
Timpani
Voice
Joy!
ia.
al-le-lu-ia.
ia!
ia.
Al-le-lu-ia.
ia!
ia.
al-le-lu-ia.
ia!
gradually softer
f
gradually softer
gradually softer
ia! 14
f
al-le-lu-ia.
ia!

COLOR UNIT

Just as color has its place in nature and each one can be distingguished by its own peculiar characteristics, so we felt that each color had its place in music and that a particular color could be experienced through a musical setting. We knew that this particular idea had been used before, but on more sophisticated levels and, as far as we knew, not in the particular way we wanted to do it.

With HAILSTONES AND HALIBUT BONES by Mary O'Neill as the text, and Sister Jeremy Coughlin as the composer, we were able to "hear" color. Six were chosen: White, Red, Blue, Green, Black, and Yellow. We wanted not only our eyes to be able to distinguish the difference, but also our ears, and our whole body. This we think we did, and by the end of the unit, the children had combined art, speech, music, and dance in a truly unique way.

Sister Jeremy Coughlin was to compose within the framework of the Carl Orff Instrumentarium and the age level of the children. Upon completion of the compositions, the children were given the opportunity to experiment with them in order to see which groups captured the spirit of which colors. We wanted grades four through seven to be involved, but there was not time for all these grades to do all the colors. Also, we found that the mood of the different colors certainly could be expressed better by some age levels than by others. Final decision on who would do certain things was not made until almost the end of the unit so that many children could experience the various activities and would not be molded into one part. Although we wanted the finished activity to be something the students could take pride in, we did not aim at an absolute perfection which would destroy freshness, joy, and a keen sense of participation. Since the children did not compose the music, which is what originally had been planned, we wanted creativity to play a big part in how it was to be done. Many of the suggestions of the children were used, and their suggestions turned out to be truly perceptive and just the right touch. A proof that the children were not tired of the activity after it was over was that the day after they did it for their parents they wanted to do it again and again, not as a performance for someone, but purely for their own enjoyment.

WHITE

"White is the shining absence of all color." So is written one of the lines of the poem. White is rather elusive, therefore the music should be much the same way. Lighter instruments were used, ones with a ringing quality. The fifth grade children were able to capture the spirit of this one. It was a small group with an equal number of boys and girls. Their voices were light in quality and they had neither the boisterness of the fourth graders, nor the changing voice problem of the older children.

Lines were spoken in various ways. Sometimes one voice, sometimes two or three, sometimes the group did the speaking, but we let it grow out of the situation and did what came the most naturally to the group. Perhaps another class would do it differently, depending on the individuals involved. Good speech habits were used here, as, in order to keep the lightness which we wanted - and still be heard, the children had to use good diction and project the voice.

Staging for this color was decided by the voice groupings. Where there was a single voice, the child stood alone. Where two spoke, two were together, so that even the staging depended upon the interpretation and was not planned ahead by the teacher.

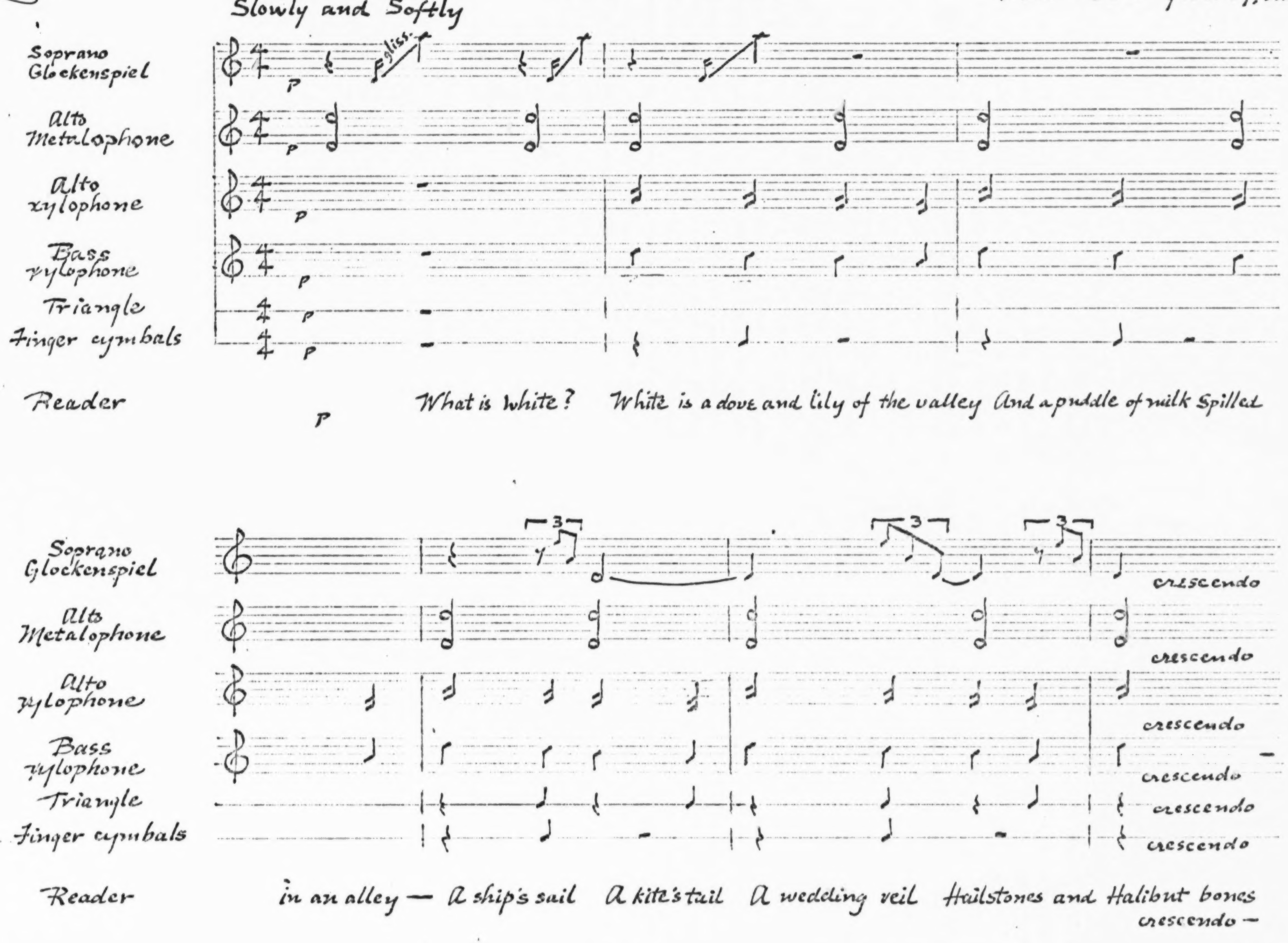
The music for this color was not easy and the children had to develop a good sense of timing. Although standing apart from one another, the inner pulsation of the music unified them and you could see them acting as a group yet able to act responsibly as an individual. I believe each child experienced his importance as a person since each single part was so important to the whole.

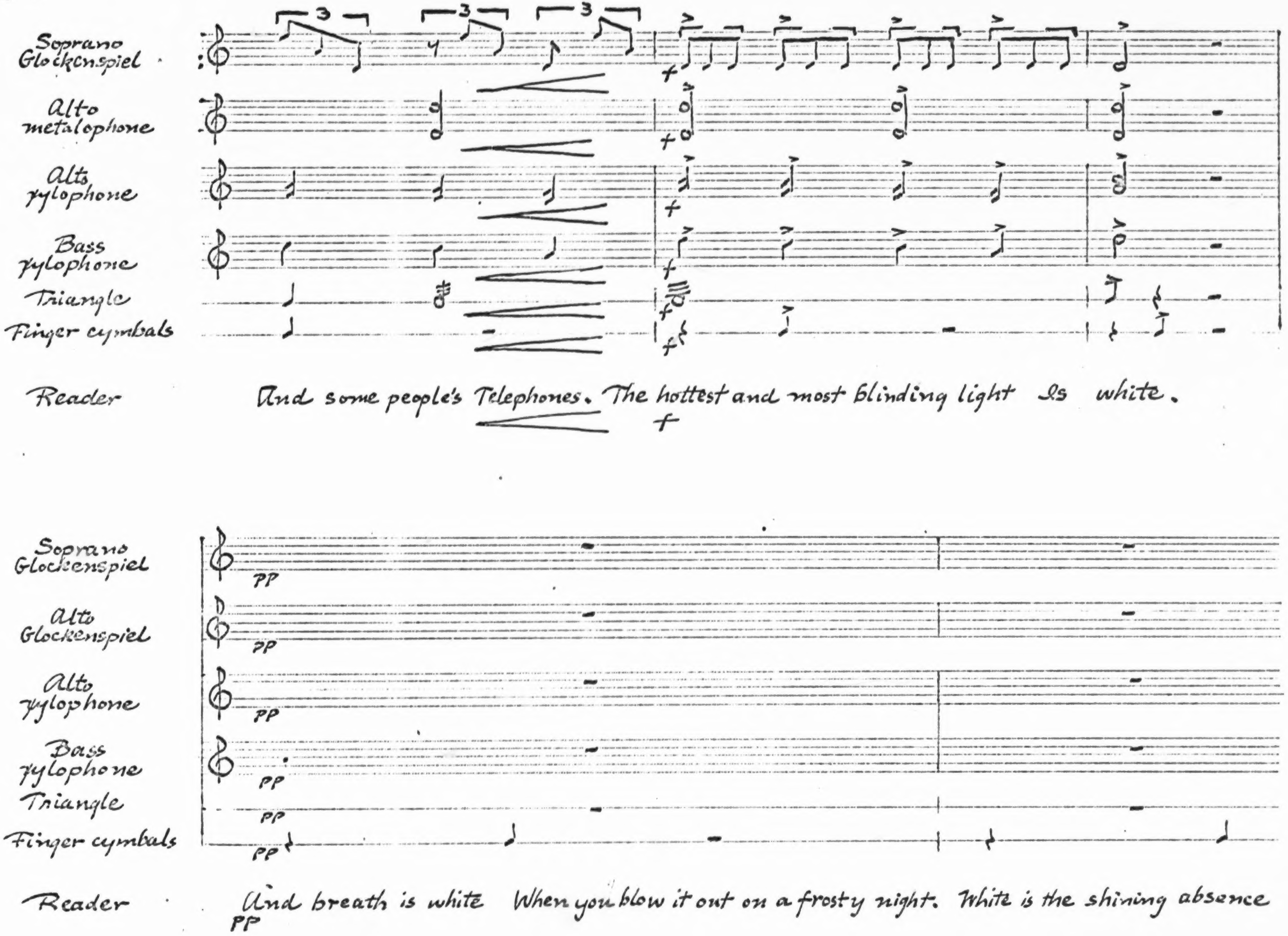
This color, when practiced, had a very calming effect on the youngsters. The feeling of white was evident, quiet and peaceful. The word reverence could pretty well sum up the atmosphere.

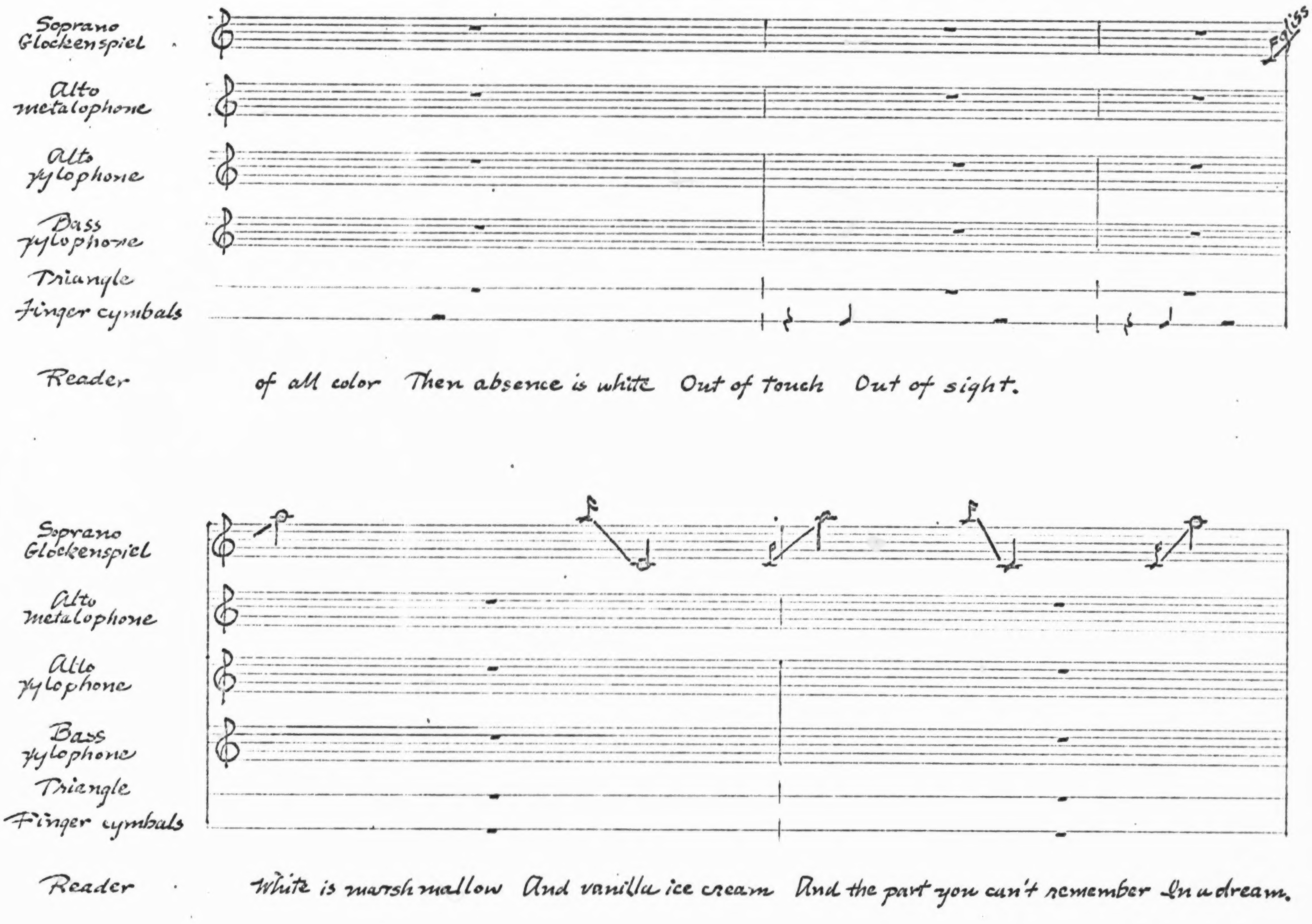
Poem: Mary O'Neill

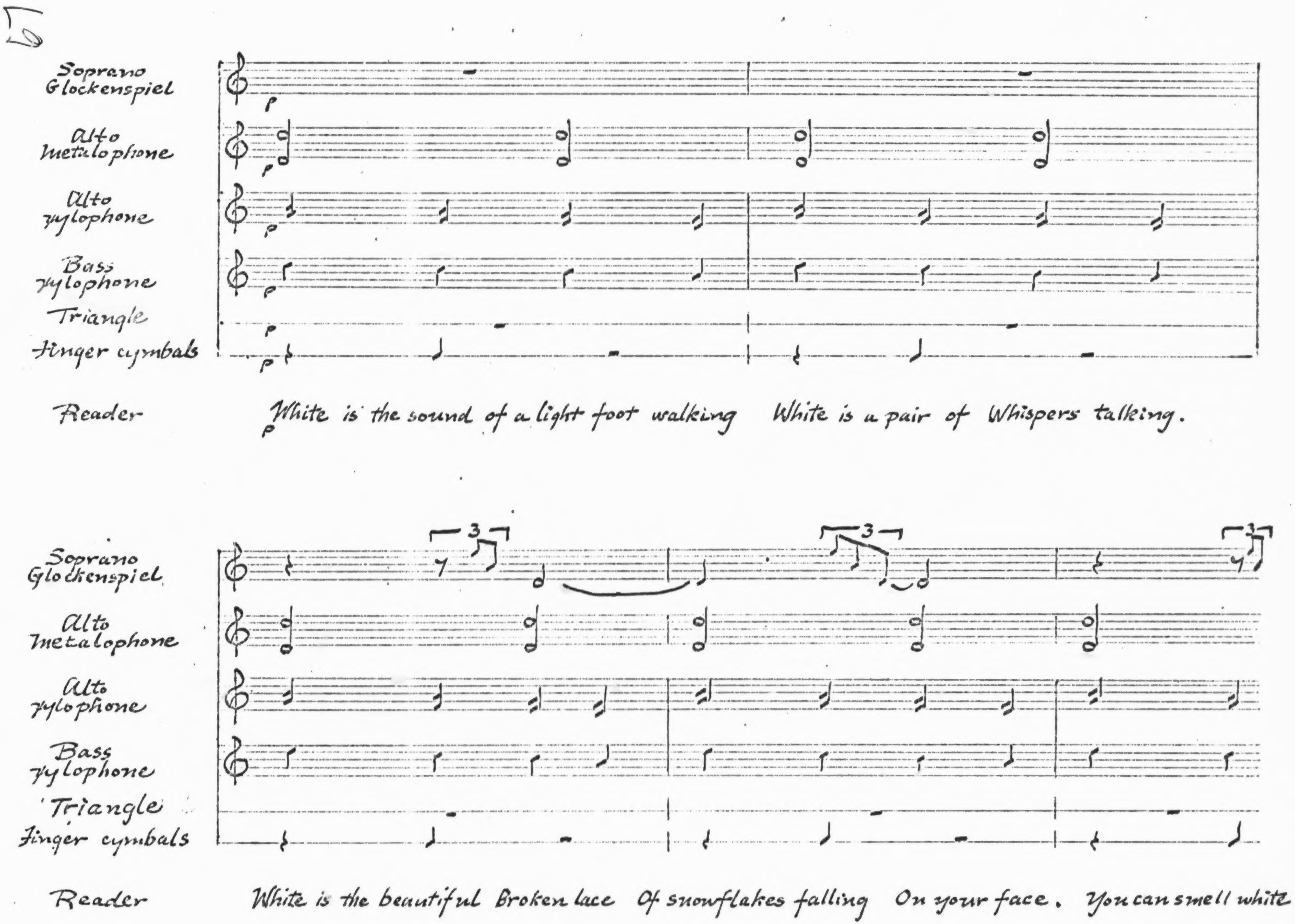
What is White?

Music: Sister Jeremy, S.L.

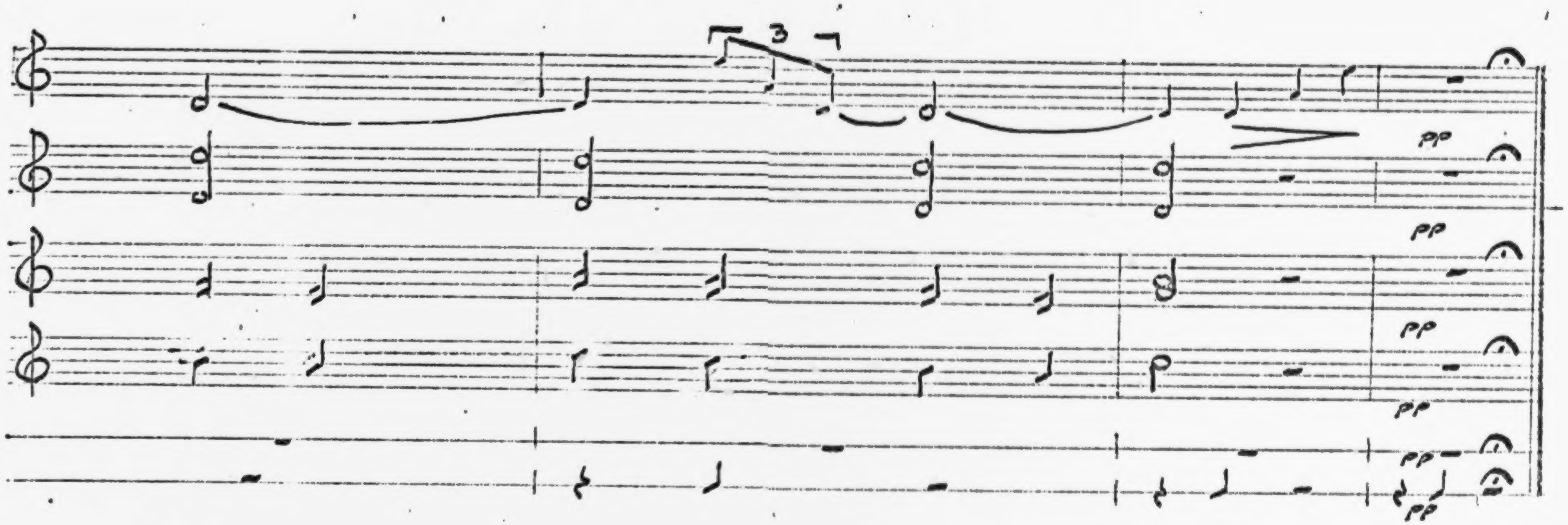

Slowly and Softly
Soprano Glockenspiel
Alto Metalophone
Alto xylophone
Bass xylophone
Triangle
Finger cymbals
Reader
p
gliss.
What is White?
White is a dove and lily of the valley
And a puddle of milk Spilled
3
crescendo
in an alley —
A ship's sail
A kite's tail
A wedding veil
Hailstones and Halibut bones
crescendo —


Soprano Glockenspiel
Alto metalophone
Alto xylophone
Bass xylophone
Triangle
Finger cymbals
Reader
And some people's Telephones. The hottest and most blinding light Is white.
f
Soprano Glockenspiel
Alto Glockenspiel
Alto xylophone
Bass xylophone
Triangle
Finger cymbals
Reader
pp
And breath is white When you blow it out on a frosty night. White is the shining absence


Soprano Glockenspiel
Alto metalophone
Alto xylophone
Bass xylophone
Triangle
Finger cymbals
Reader
Gliss.
of all color Then absence is white Out of touch Out of sight.
Soprano Glockenspiel
Alto metalophone
Alto xylophone
Bass xylophone
Triangle
Finger cymbals
Reader
White is marshmallow And vanilla ice cream And the part you can't remember In a dream.


6
Soprano Glockenspiel
Alto Metalophone
Alto Xylophone
Bass Xylophone
Triangle
Finger cymbals
Reader
p
White is the sound of a light foot walking White is a pair of Whispers talking.
3
White is the beautiful Broken lace Of snowflakes falling On your face. You can smell white

68


3
pp
pp
pp
pp
pp
pp
pp

In a country room Toward the end of May In the cherry bloom.

pp

RED

Red is a noisy color. Once the fourth graders tried this one, there was no doubt that it was theirs. They are a lively, inventive group and wanted this color to be all theirs. Furthermore, this poem lent itself to solo lines, and it so happened that there were as many lines as children, so that each child got to say something. Of all the colors, this one was the most successful. By the time we finished, every child in the room, most of whom where boys, could speak every part, play every instrument, and knew just what to do, so there was no worry of someone being missing for the performance. There were plenty of substitutes!

As for staging, each child was on his own. No two stood together, and since the composition moved quite fast, alertness and attention was always at a high peak. This was very good for group mental coordination. Once we began work on this color, there were no sleepy heads. Even children that were more or less phlegmatic in other classes, were alert for this one. They didn't want to miss their line. And no one did.

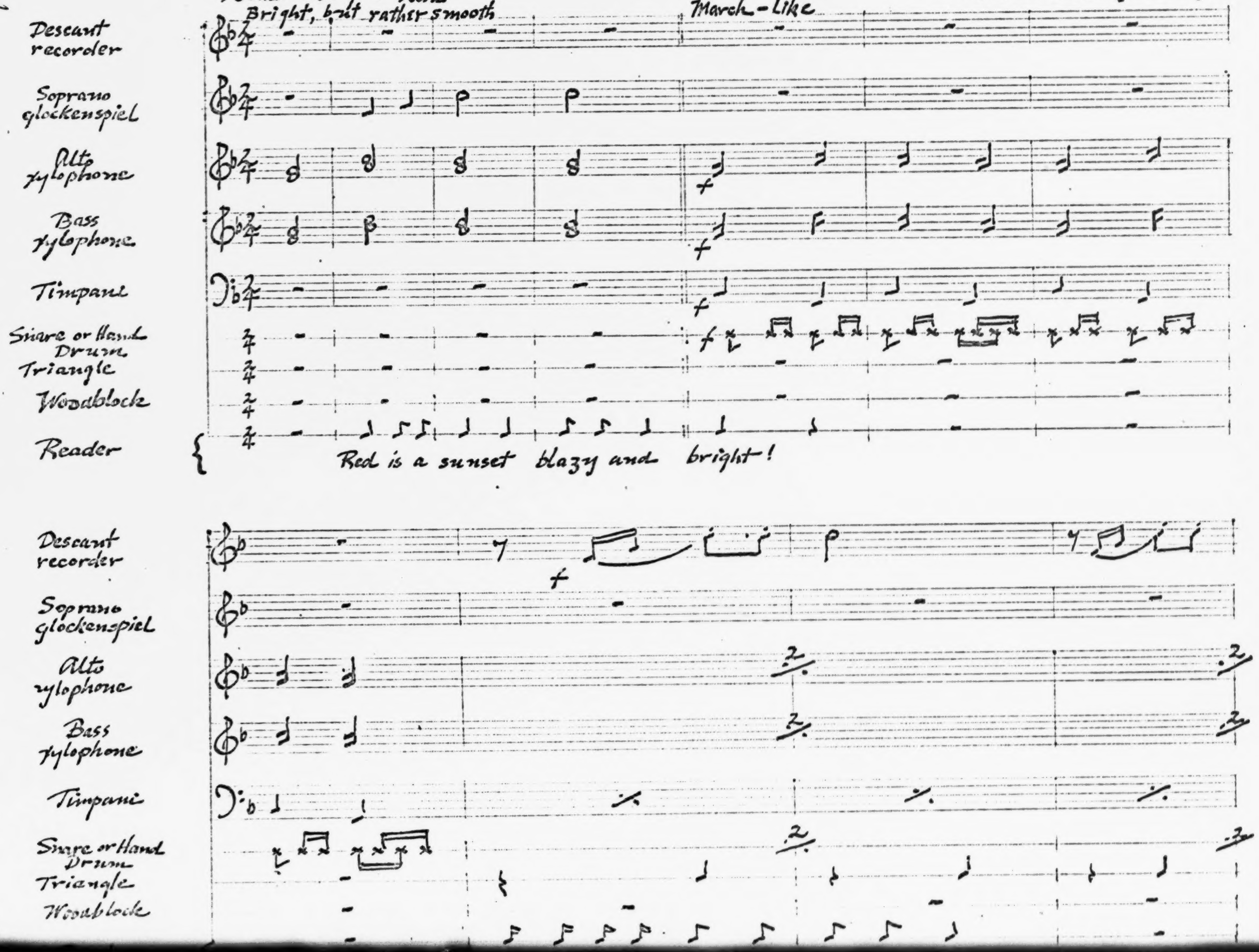
The most difficult instrument arrangement for red was the drum. All the boys wanted to do the drumming, so there was much practice outside of regular music class which helped improve their sense of rhythm and also to coordinate their left and right hand movements.

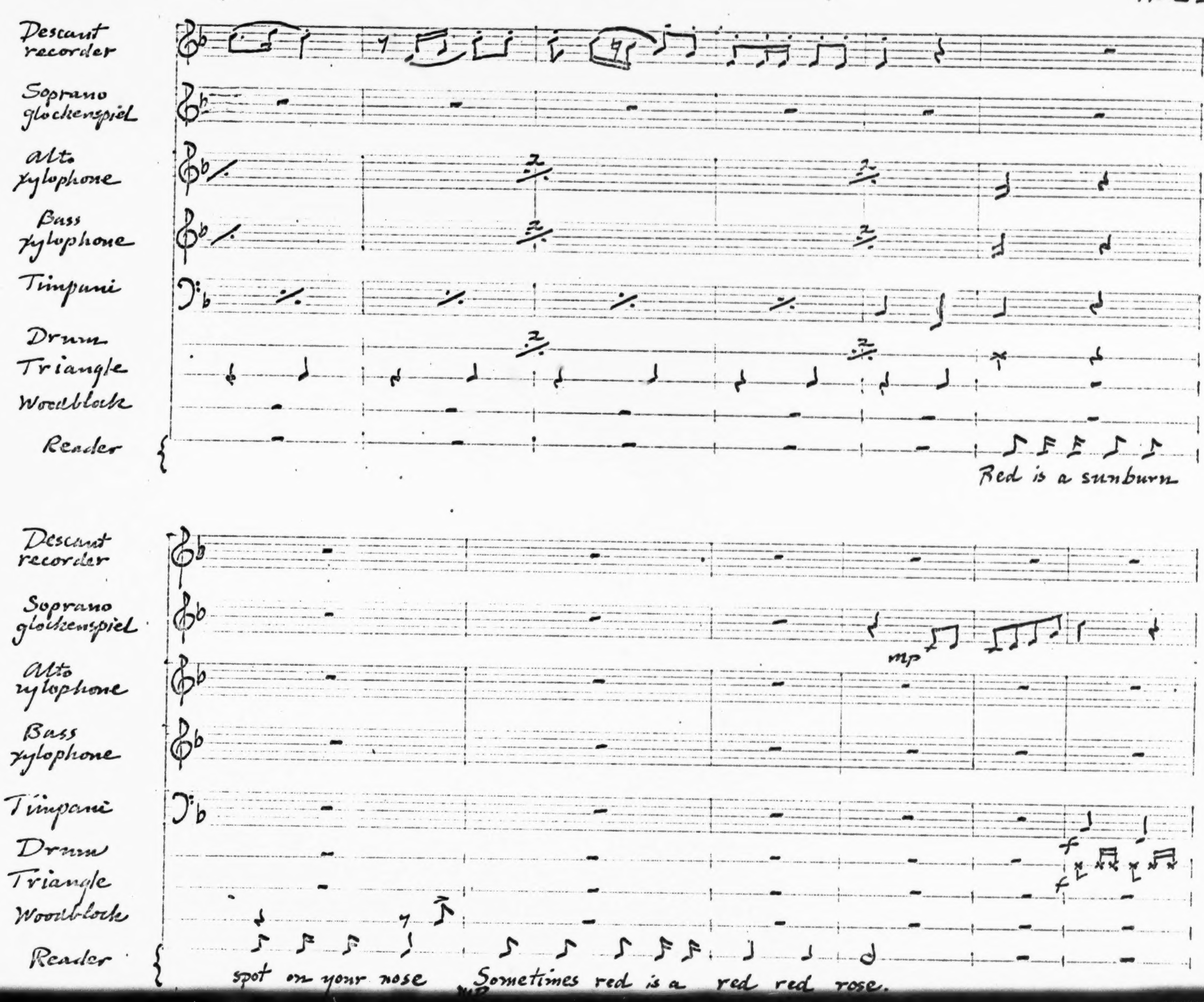
Speech and timing greatly improved through work on this particular piece which showed up in their other classes. Many of these children were chronologically third grade level, and yet were doing techniques in music that many fifth and sixth grade children find difficult. Enthusiasm and a sense of participation can develop the potential in many a child who otherwise might be labeled musically illiterate.

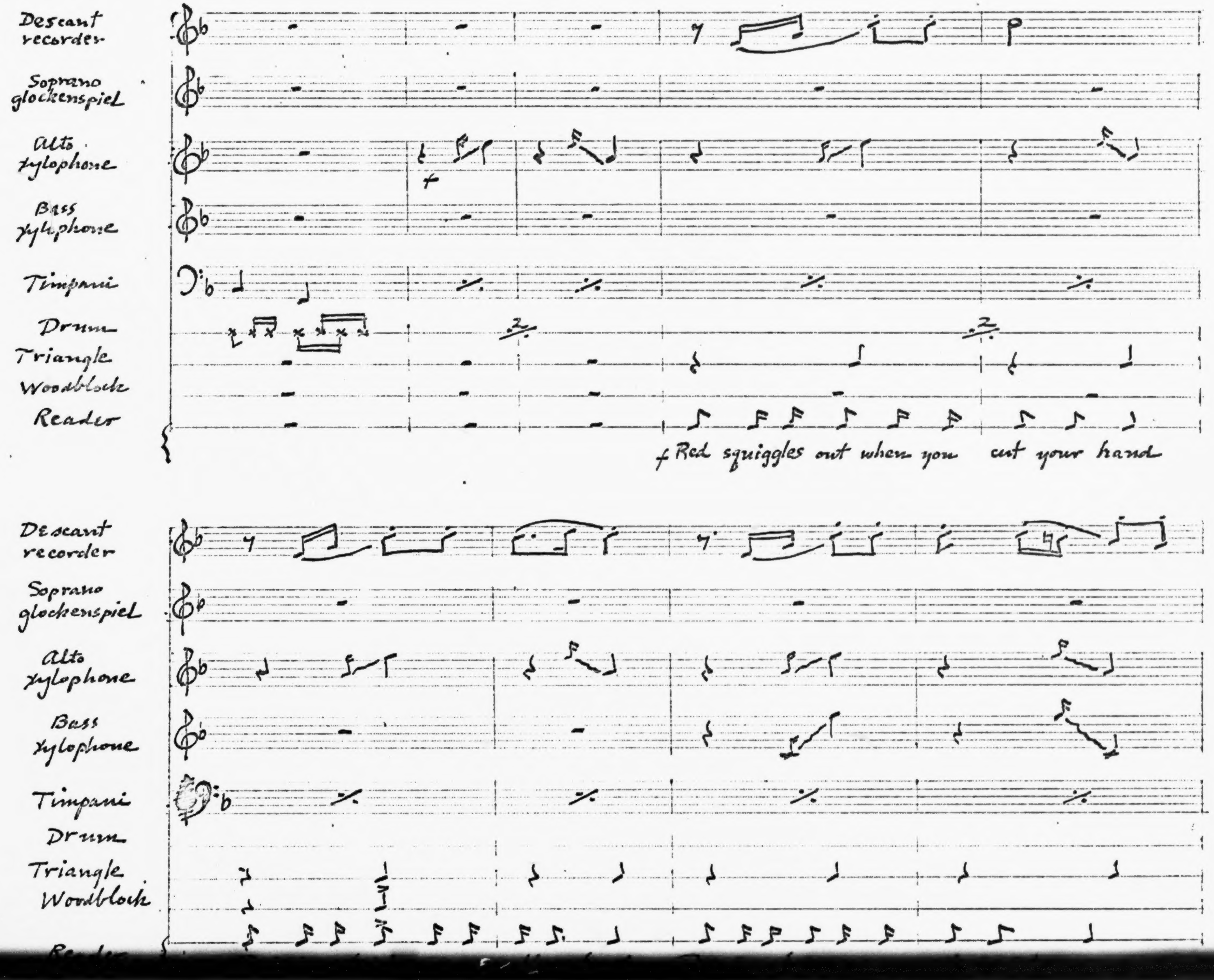
What is Red?

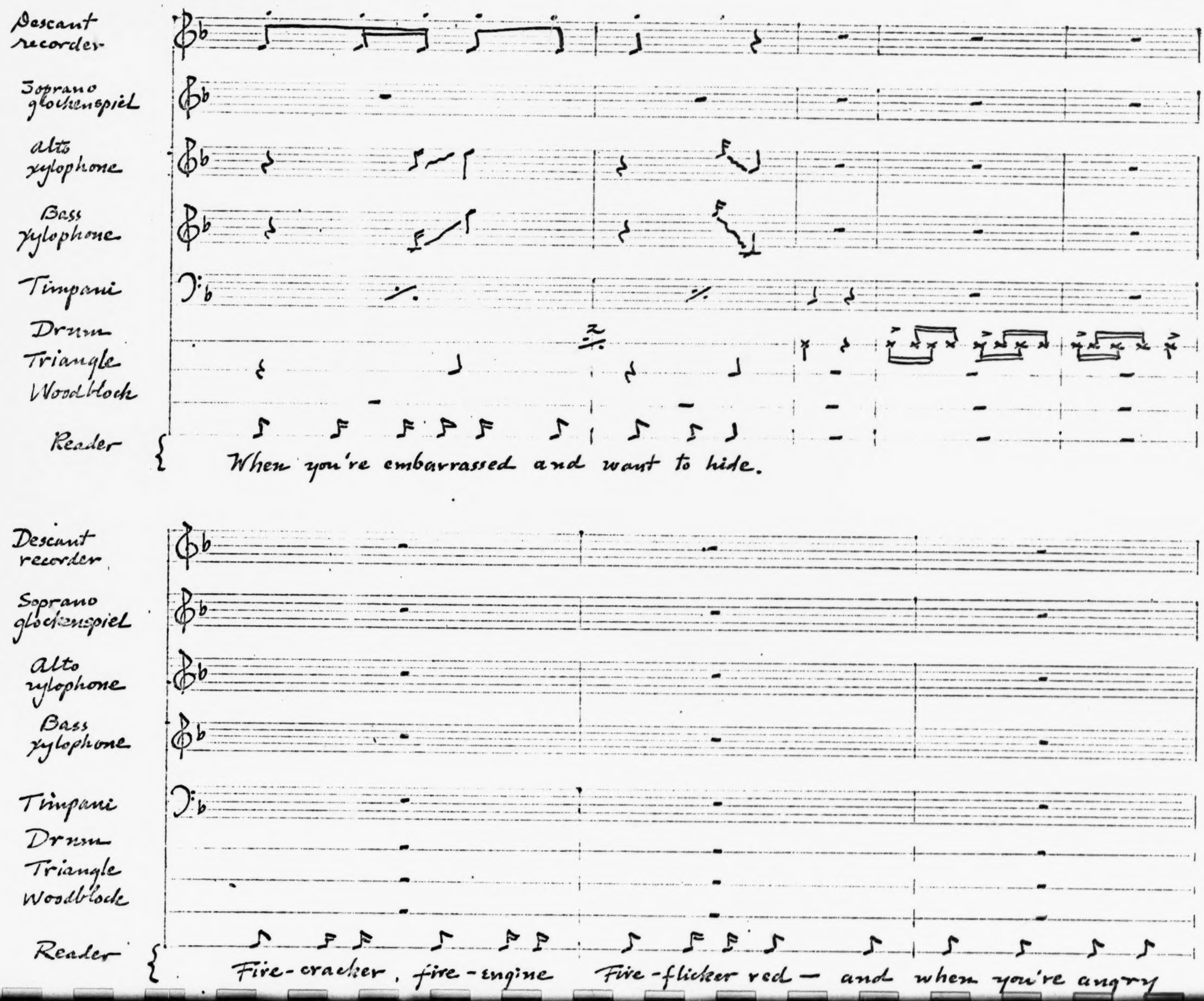
Poem: Mary O'Neill

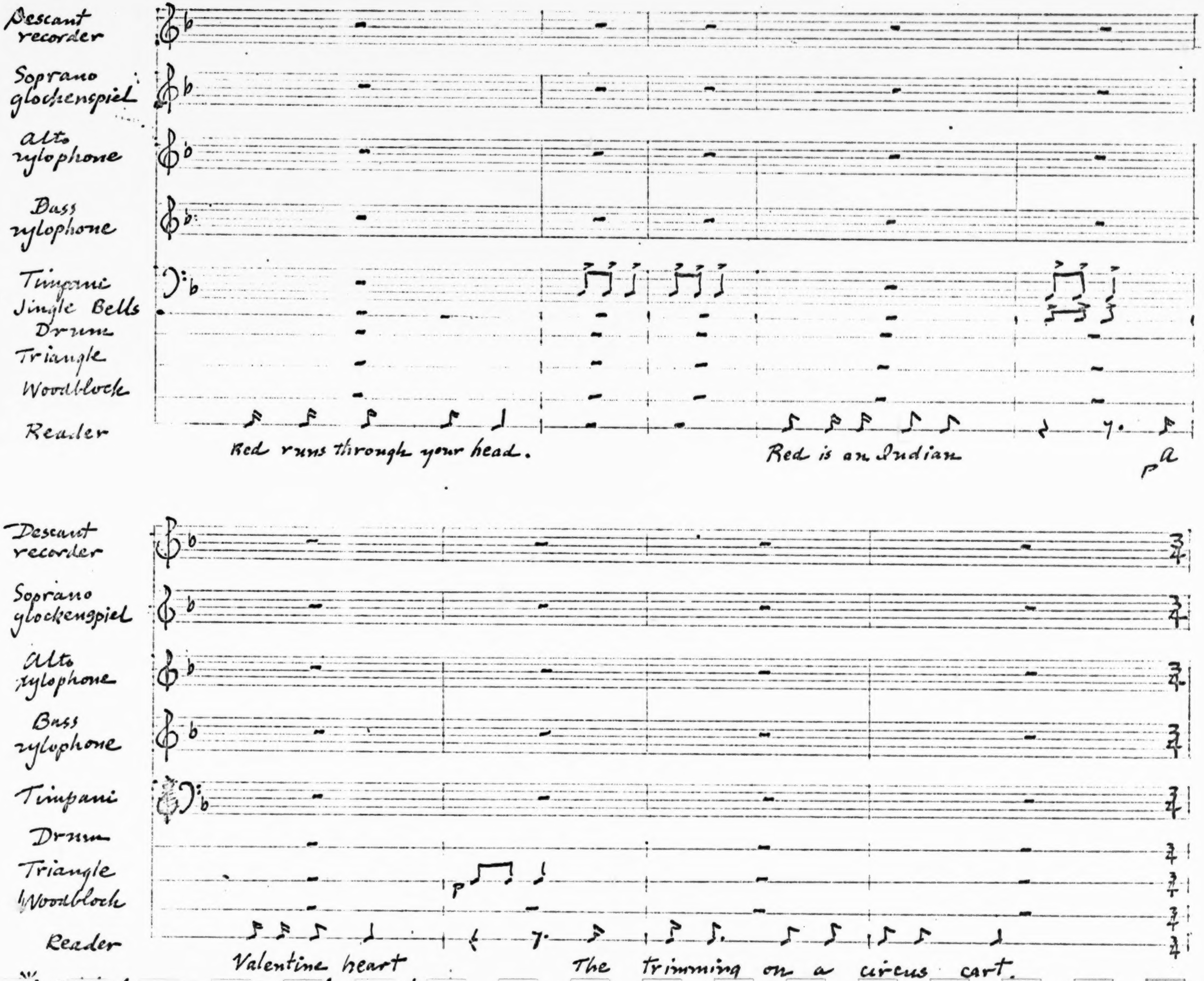
Music: Sister Jeremy, S.L.


Bright, but rather smooth
March-Like
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Snare or Hand Drum
Triangle
Woodblock
Reader
Red is a sunset blazy and bright!
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Snare or Hand Drum
Triangle
Woodblock

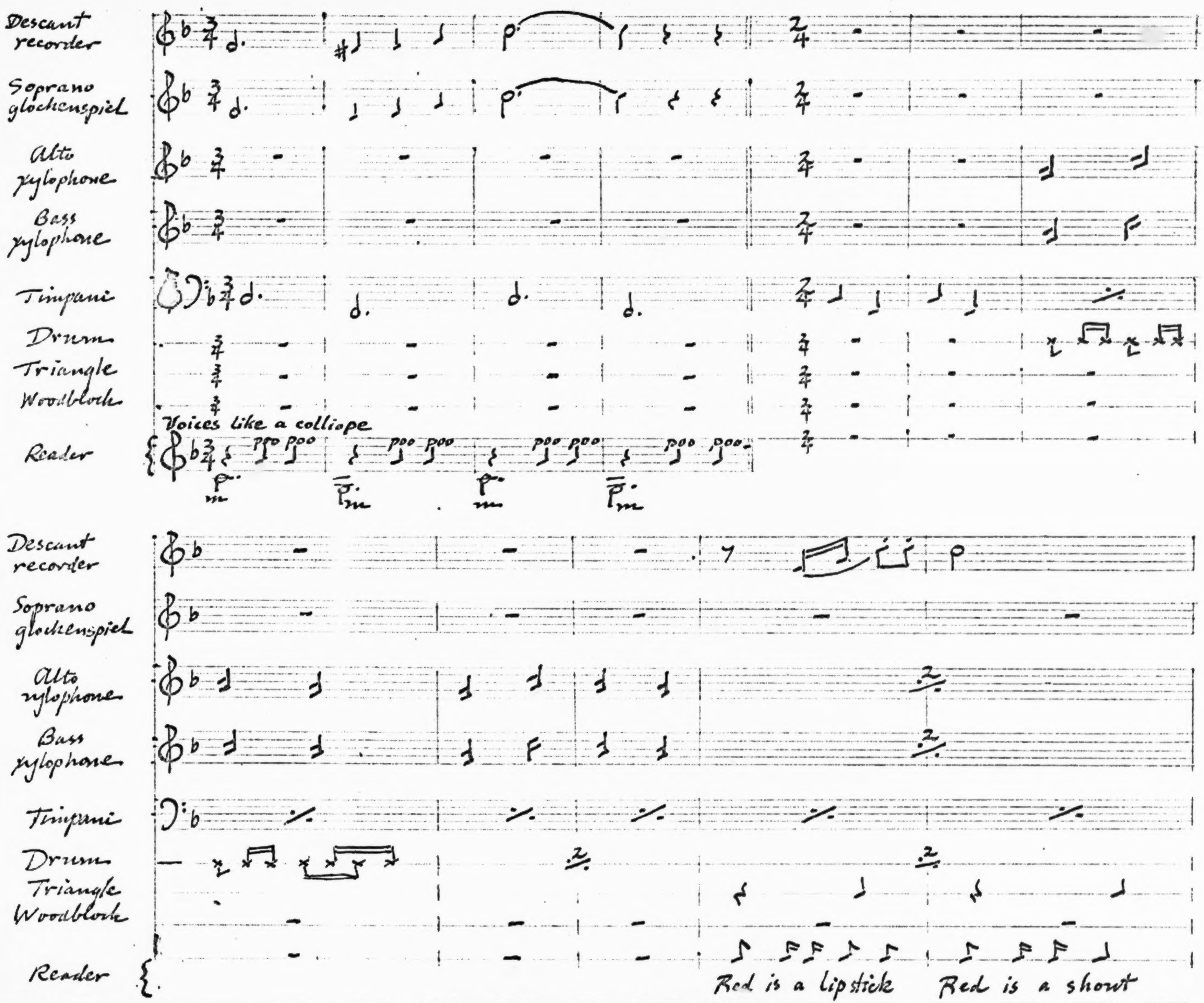

Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
Red is a sunburn
Descant recorder
Soprano glockenspiel
mp
Alto xylophone
Bass xylophone
Timpani
Drum
f
Triangle
f
Woodblock
Reader
spot on your nose
mp
Sometimes red is a red red rose.

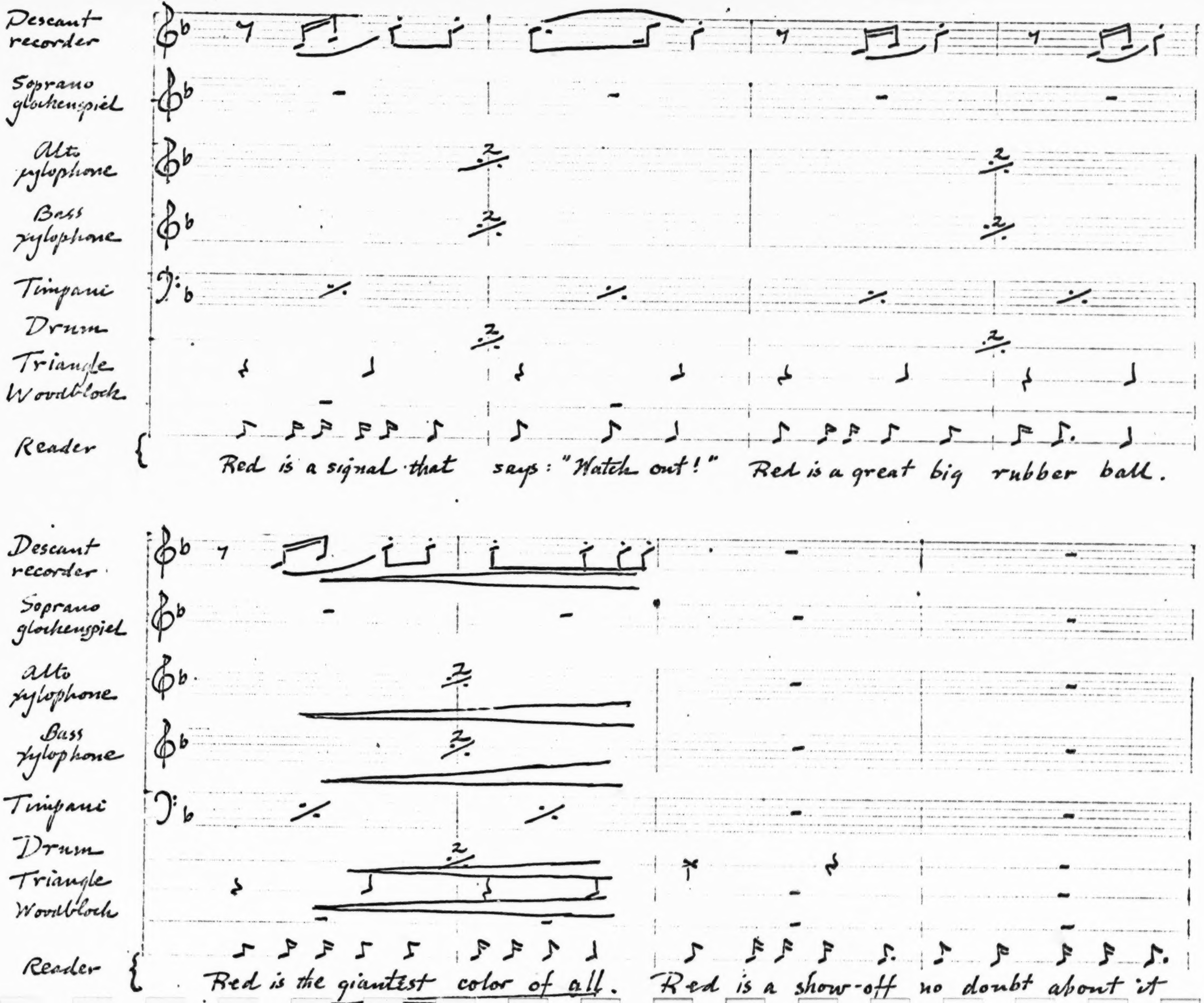

Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
f Red squiggles out when you cut your hand
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock

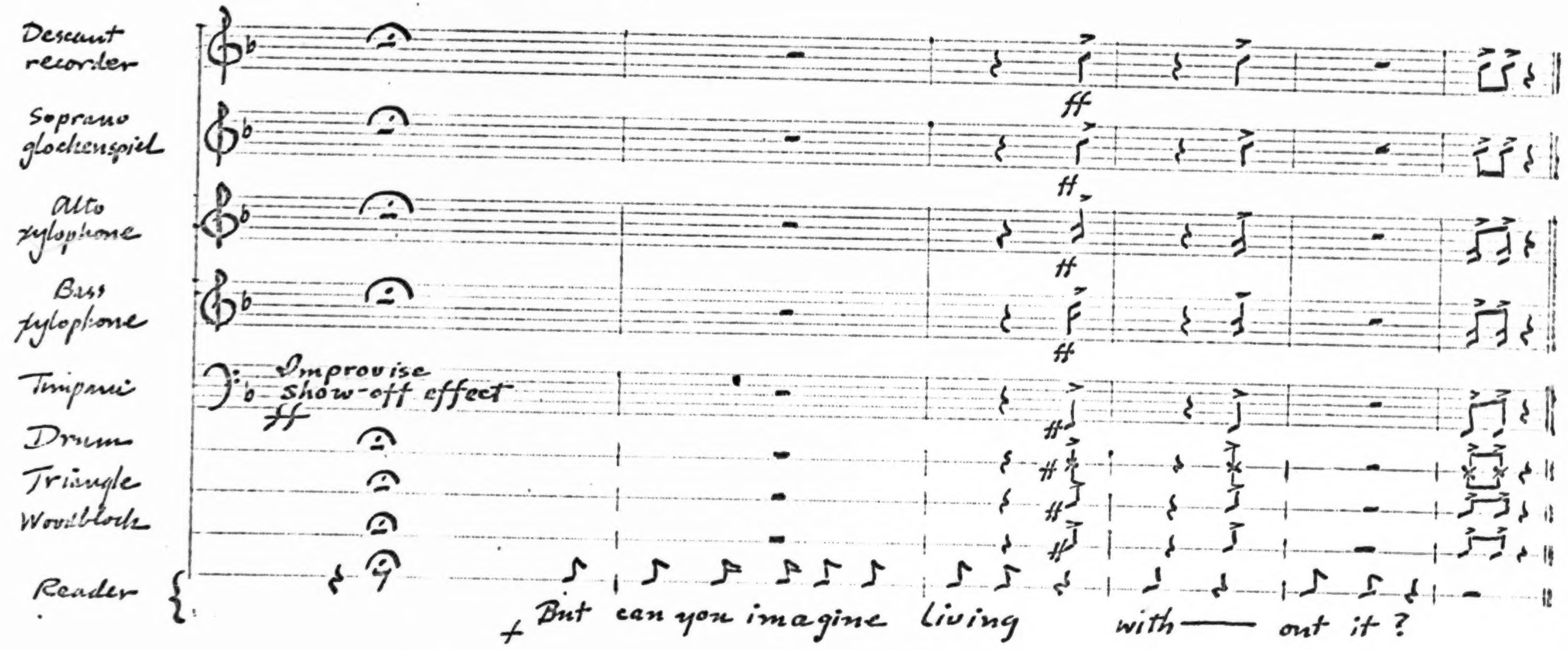

Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
When you're embarrassed and want to hide.
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
Fire-cracker, fire-engine Fire-flicker red — and when you're angry


Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
* Jingle Bells
Drum
Triangle
Woodblock
Reader
Red runs through your head.
Red is an Indian
p a
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
p
Valentine heart
The trimming on a circus cart.

*. a [illegible] ed [illegible] e [illegible] spe [illegible] ct


Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Voices like a colliope
Reader
poo poo
poo poo
poo poo
poo poo
m
m
m
m
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
Red is a lipstick
Red is a shout


Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
Red is a signal that says: "Watch out!" Red is a great big rubber ball.
Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
Red is the giantest color of all. Red is a show-off no doubt about it


Descant recorder
Soprano glockenspiel
Alto xylophone
Bass xylophone
Timpani
Drum
Triangle
Woodblock
Reader
Improvise show-off effect
ff
ff
ff
ff
ff
+ But can you imagine living with—— out it?

BLUE

This is the only color in which just a small group of children took part. There is a place for the more gifted child, and we were able to use the talented children for this color. The age level was that of sixth and seventh graders. The music, which is of a more sophisticated nature, needed the more mature child.

Since the children for this experiment were musically talented, they were given the freedom to work out the parts. The boy who played the guitar was a very difficult boy to teach ordinarily, but given the freedom here, he was most anxious to do his section and cooperated quite willingly. In fact, he asked if he could do it. The speech was done by one girl who had a deep, resonating voice and was able to put the right feeling into her voice. Another girl, extremely talented, interpreted the color with dance. No directions were given her. She listened and then made her own choreography. The other instruments were done by boys who read music well and had a good sense of rhythm.

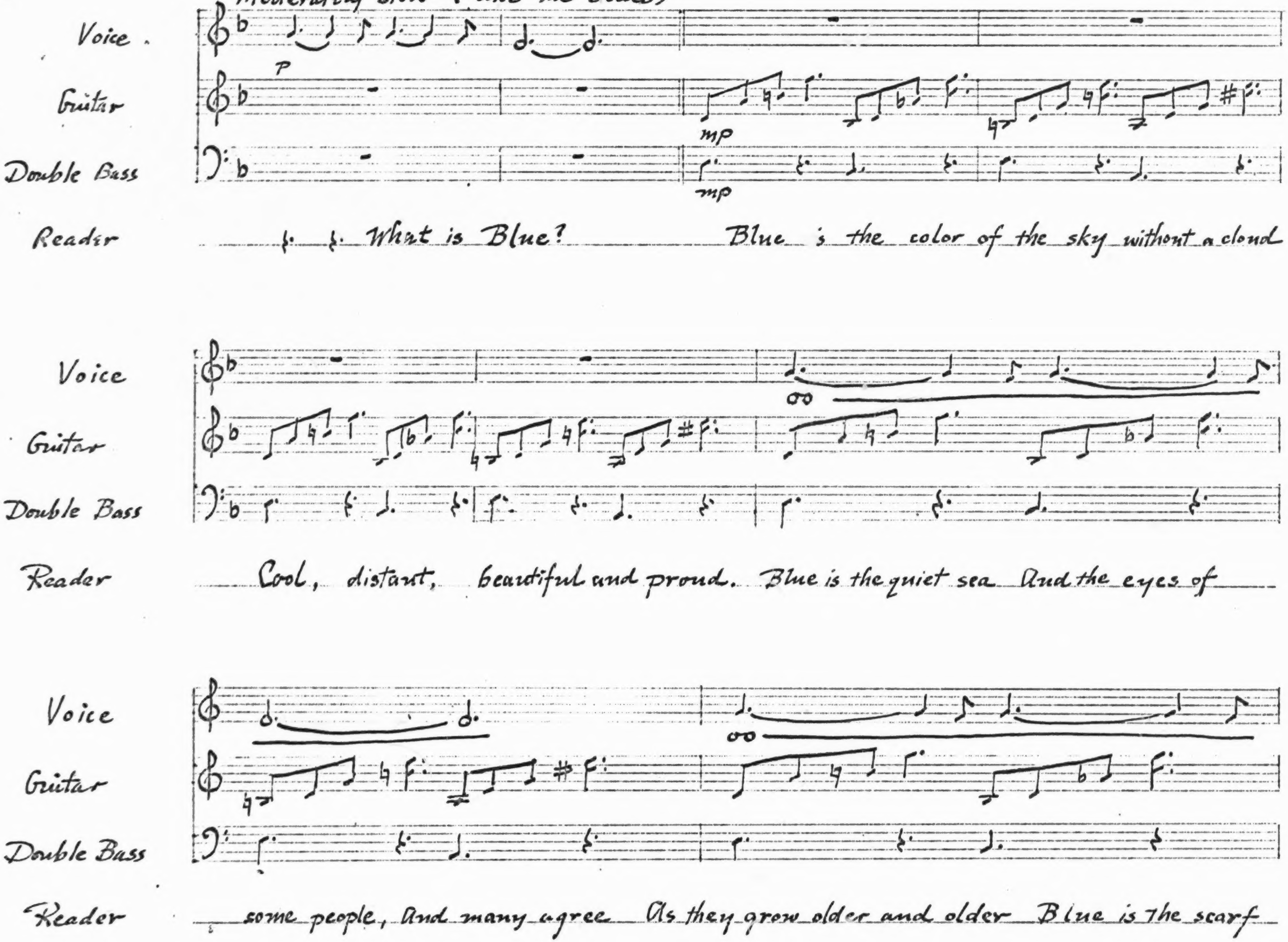
This group caught the Blue feeling quite well, and it was a good experience for a group that was highly intelligent and capable of working together. This opportunity is not often given to this type of child, but is rewarding when it is.

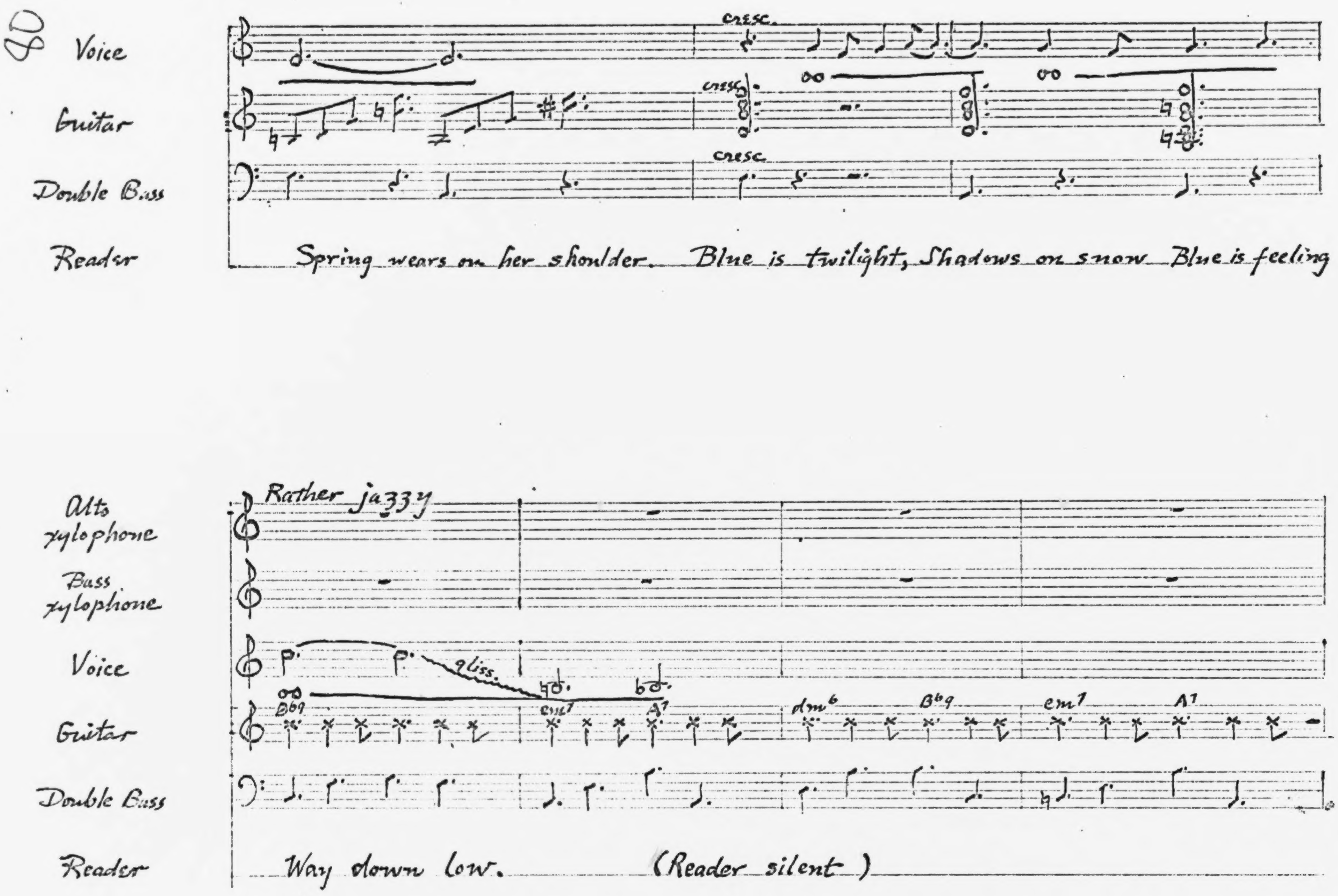
What is Blue?

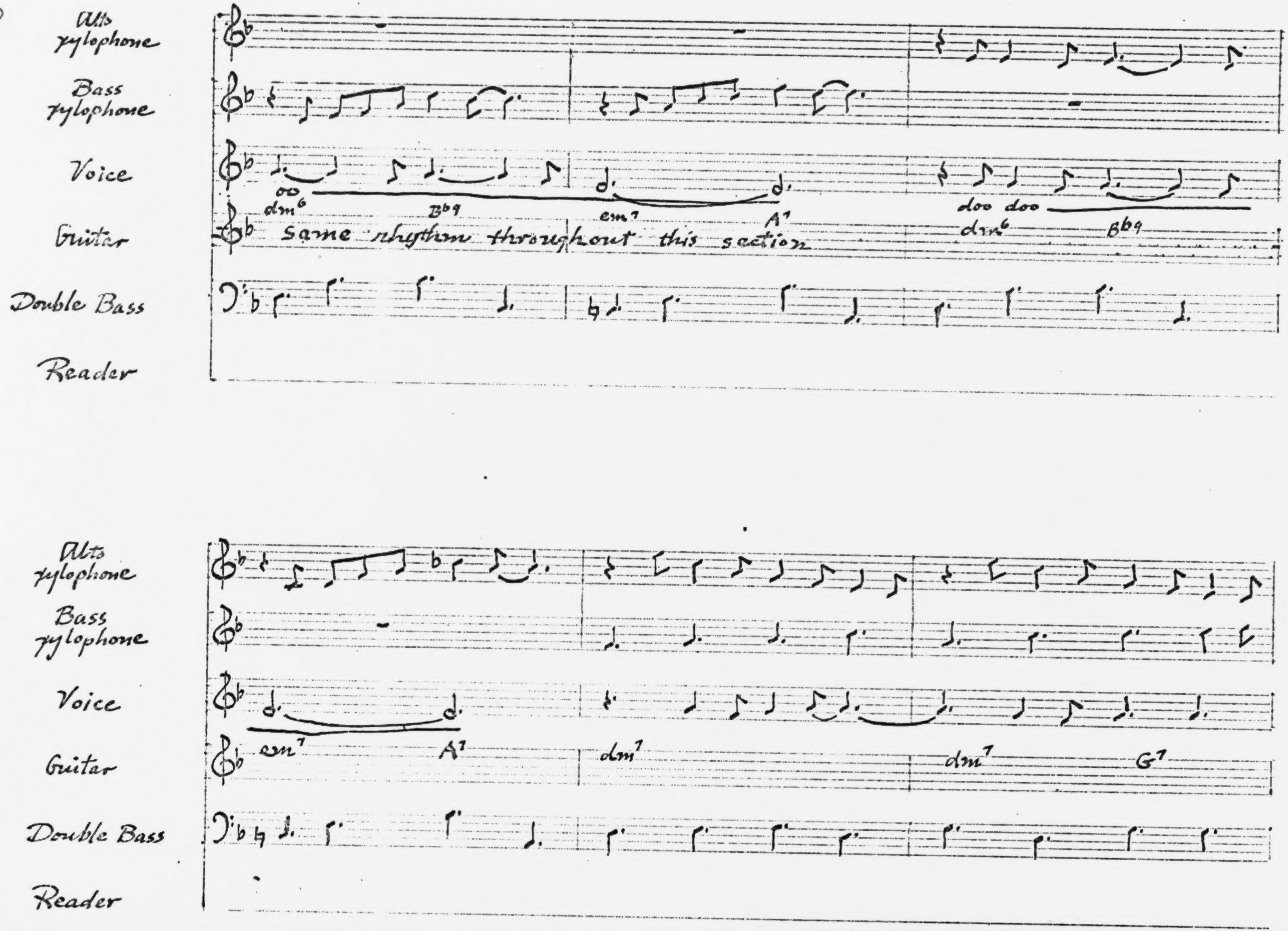
Poem: Mary O'Neill

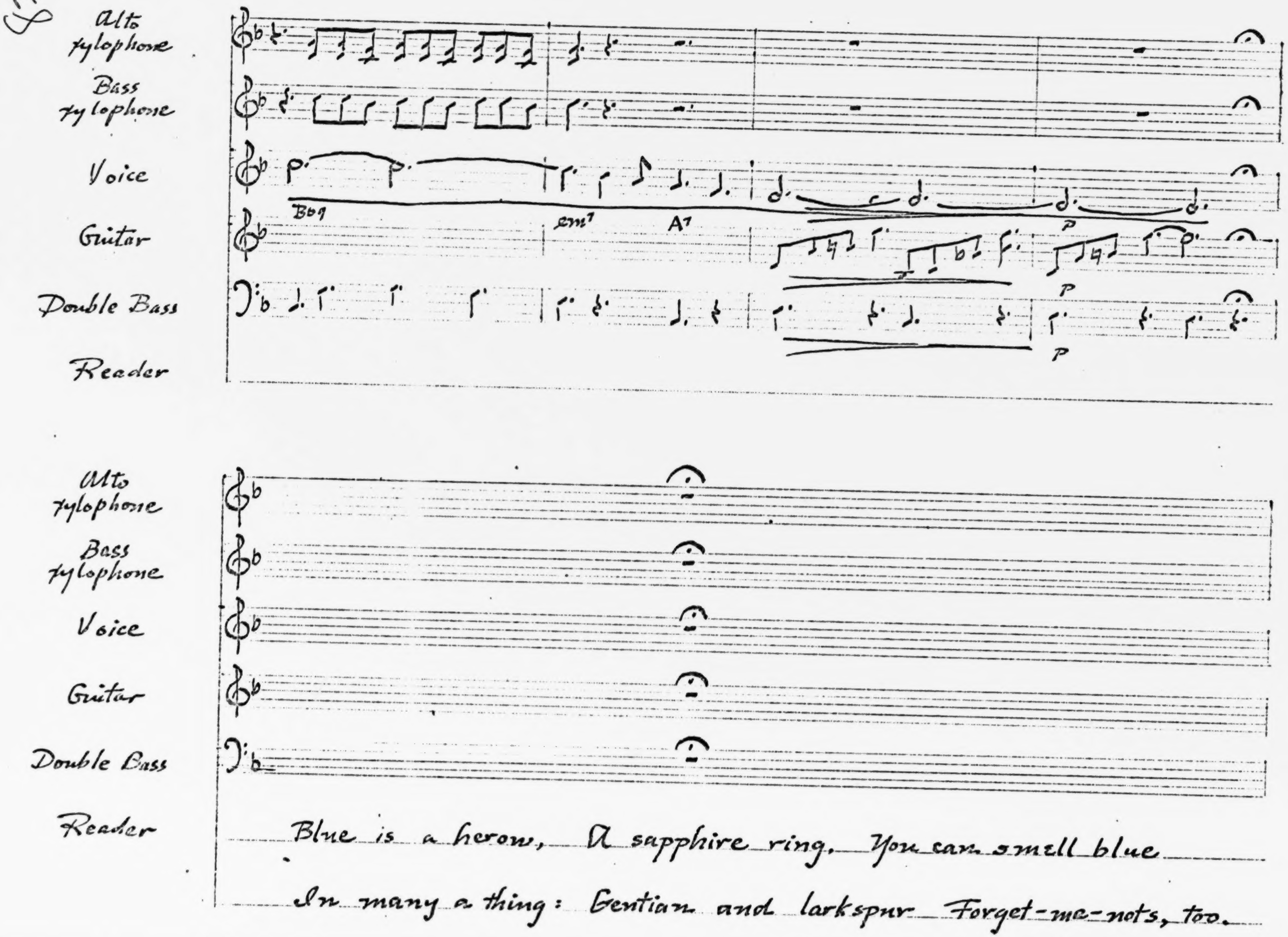
Music: Sister Jeremy, S.L.

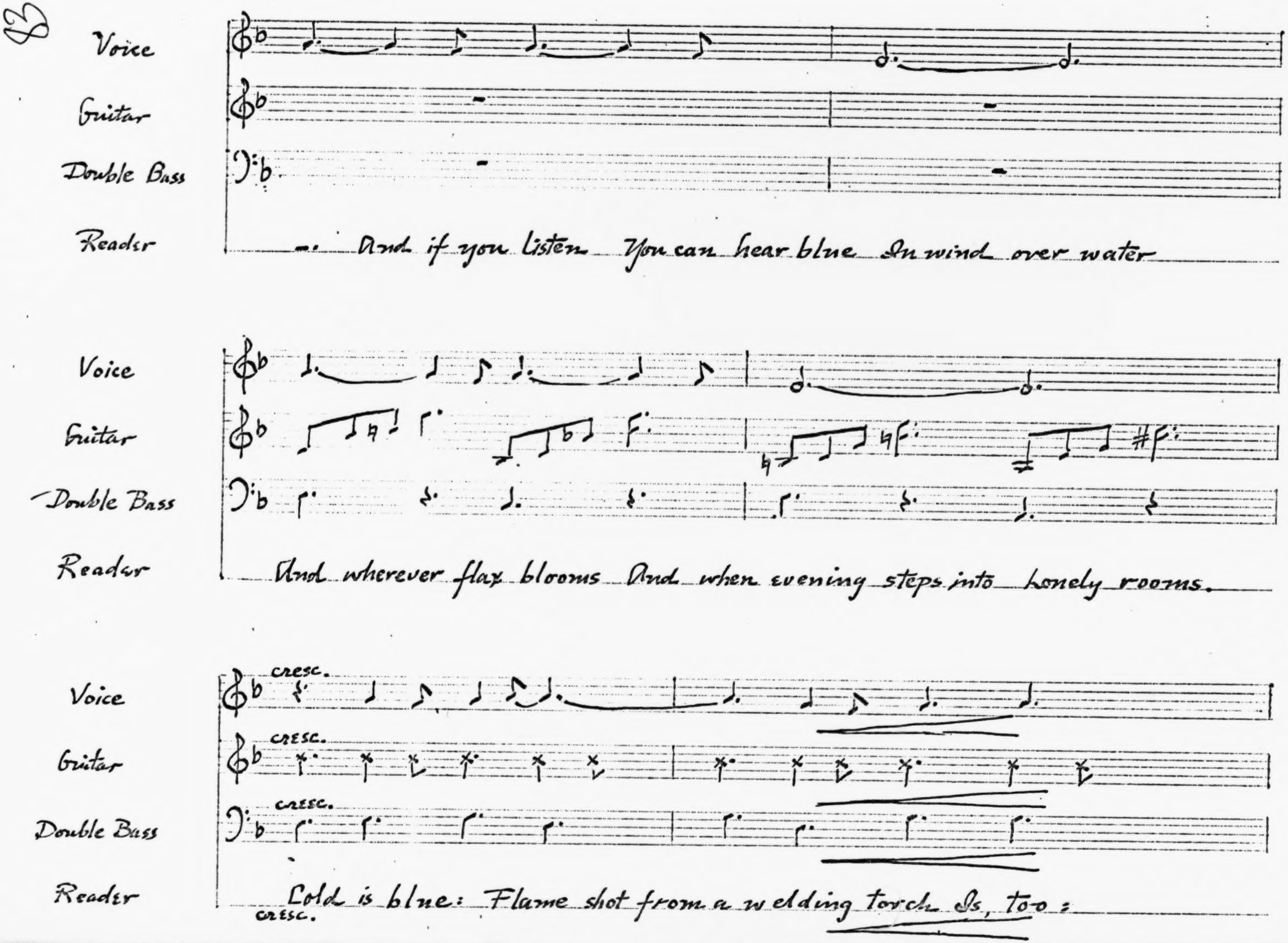
Moderately slow (like the blues)

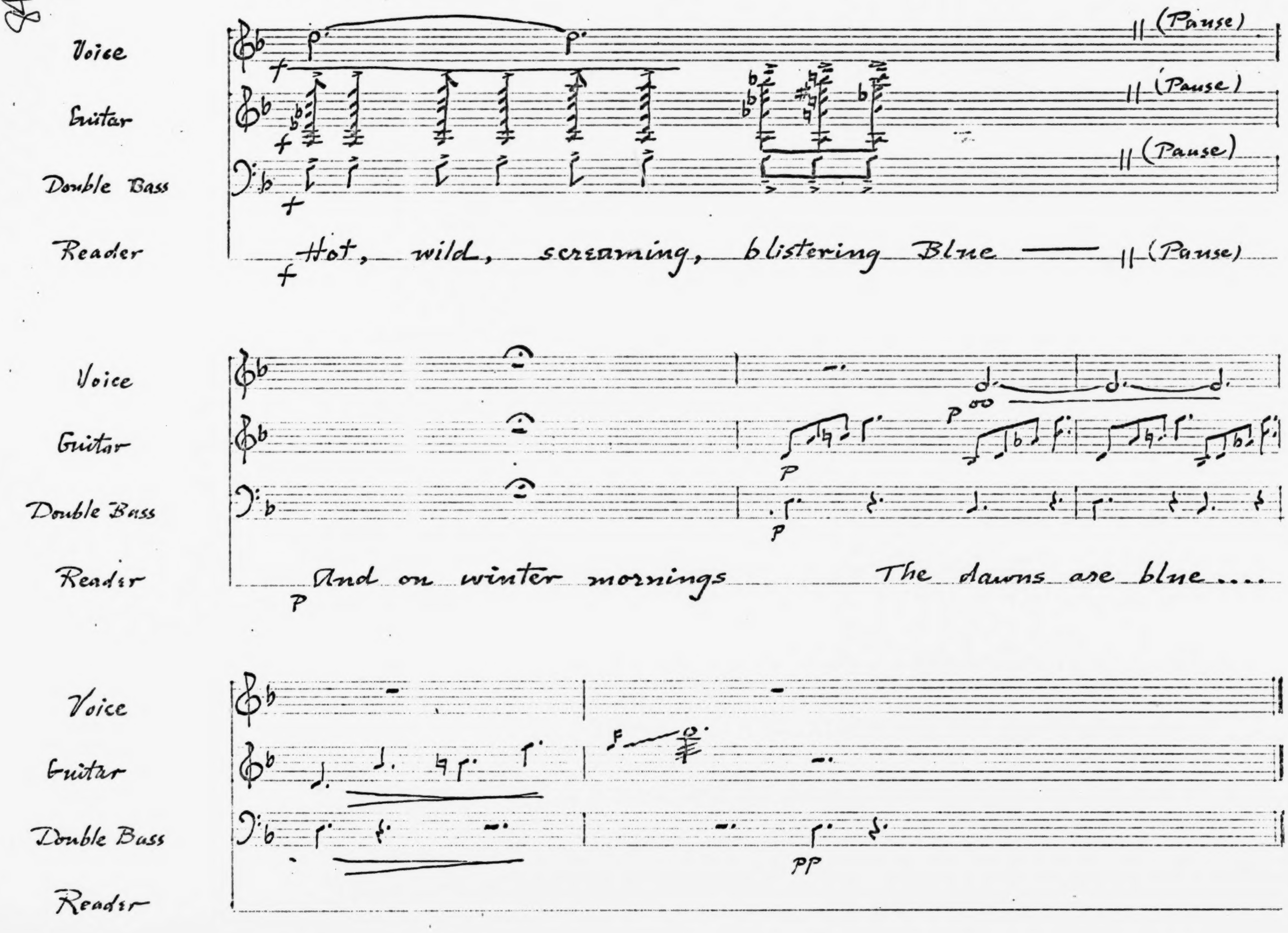

Voice
Guitar
Double Bass
Reader
p
mp
mp
What is Blue?
Blue is the color of the sky without a cloud
Cool, distant, beautiful and proud. Blue is the quiet sea And the eyes of
some people, And many agree As they grow older and older Blue is the scarf


40
Voice
Guitar
Double Bass
Reader
cresc.
cresc.
cresc.
Spring wears on her shoulder. Blue is twilight, Shadows on snow Blue is feeling
Alto xylophone
Bass xylophone
Voice
Guitar
Double Bass
Reader
Rather jazzy
gliss.
B♭9
em7
A7
dm6
B♭9
em7
A7
Way down low.
(Reader silent)


Alto xylophone
Bass xylophone
Voice
Guitar
Double Bass
Reader
oo
doo doo
dm⁶
B♭⁹
em⁷
A⁷
Same rhythm throughout this section
dm⁷
G⁷


Alto xylophone
Bass xylophone
Voice
Guitar
Double Bass
Reader
Bb9
em7
A7
p
p
p
Alto xylophone
Bass xylophone
Voice
Guitar
Double Bass
Reader
Blue is a heron, A sapphire ring. You can smell blue
In many a thing: Gentian and larkspur Forget-me-nots, too.


Voice
Guitar
Double Bass
Reader
And if you listen You can hear blue In wind over water
Voice
Guitar
Double Bass
Reader
And wherever flax blooms And when evening steps into Lonely rooms.
cresc.
Voice
cresc.
Guitar
cresc.
Double Bass
Reader
Cold is blue: Flame shot from a welding torch Is, too:
cresc.


Voice
Guitar
Double Bass
Reader
f
(Pause)
(Pause)
(Pause)
Hot, wild, screaming, blistering Blue —— (Pause)
Voice
Guitar
Double Bass
Reader
p
p
p
And on winter mornings The dawns are blue....
Voice
Guitar
Double Bass
Reader
pp

GREEN

Green is everyone's color. Nature has surrounded us with it. And so, green was to be the color that we all took part in.

We were able to do many things with this color. Sound effects could be used, many different kinds of instruments were appropriate to the mood, the easy waltz time made movement simple, and the melody line was as easy for younger children as for older ones. It was a relaxing color to sing and a relaxing color to learn.

Even though all the children took part in this one, we did not bring them all together to learn it. In fact, until the last couple of days, it was not necessary to be together at all. The singing could be done by a whole class, and within each class there could be some instruments and some speech. It is a good experience with this piece to see how much can be done in one group and then have the children experience the unity that can be had in a large group.

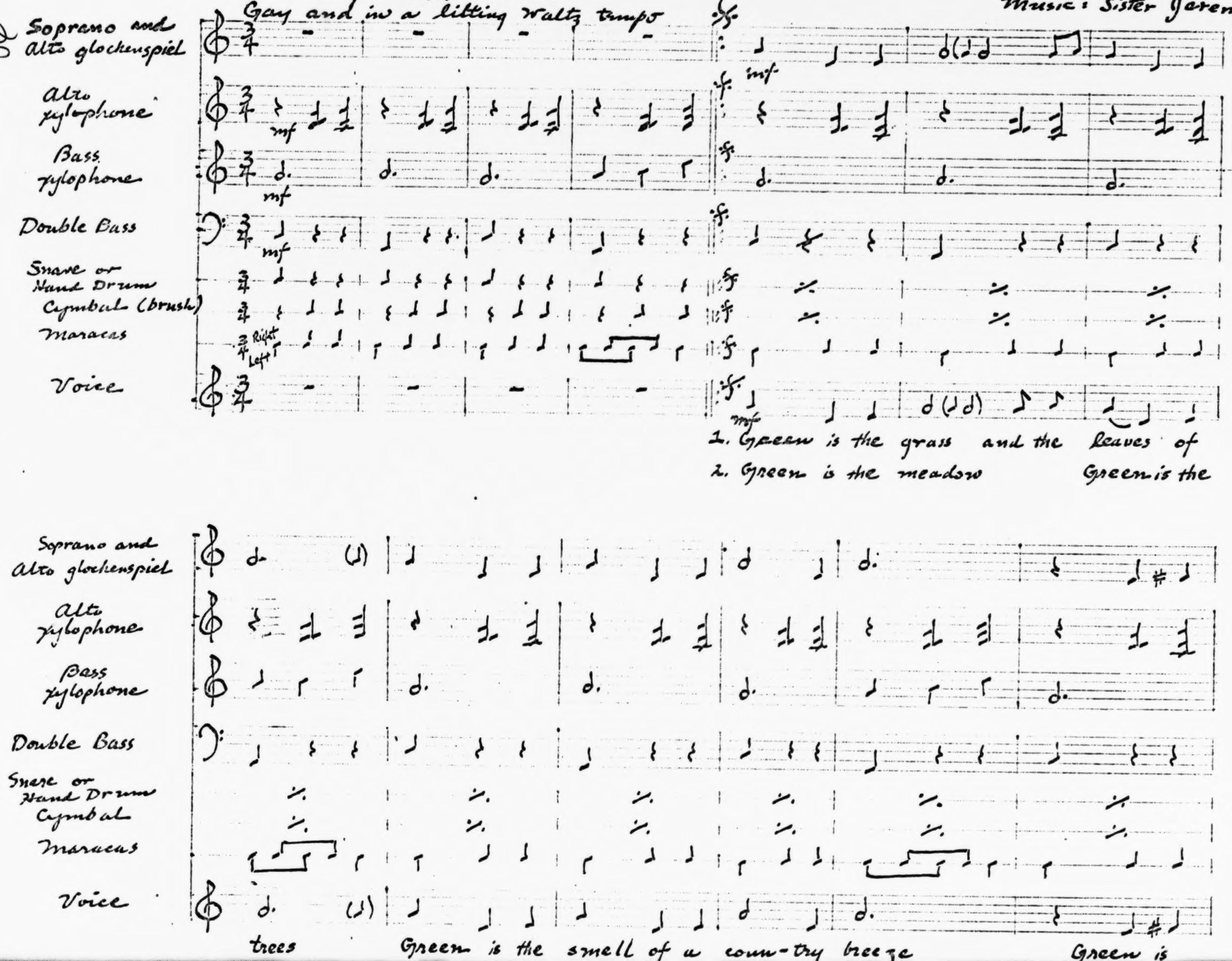
Ordinarily, the teacher does not have to be the deciding factor for choosing the children for the various speaking parts and instruments. The children are pretty observant about noticing the ones that have the proper inflection and rhythmical accuracy which something like this requires. In making the project everyone's project, there are no wounded feelings or little jealousies that obviously are aroused if the teacher does all the judging as to who will do the parts. Something like this helps the children themselves to recognize individual differences and how talents are divided.

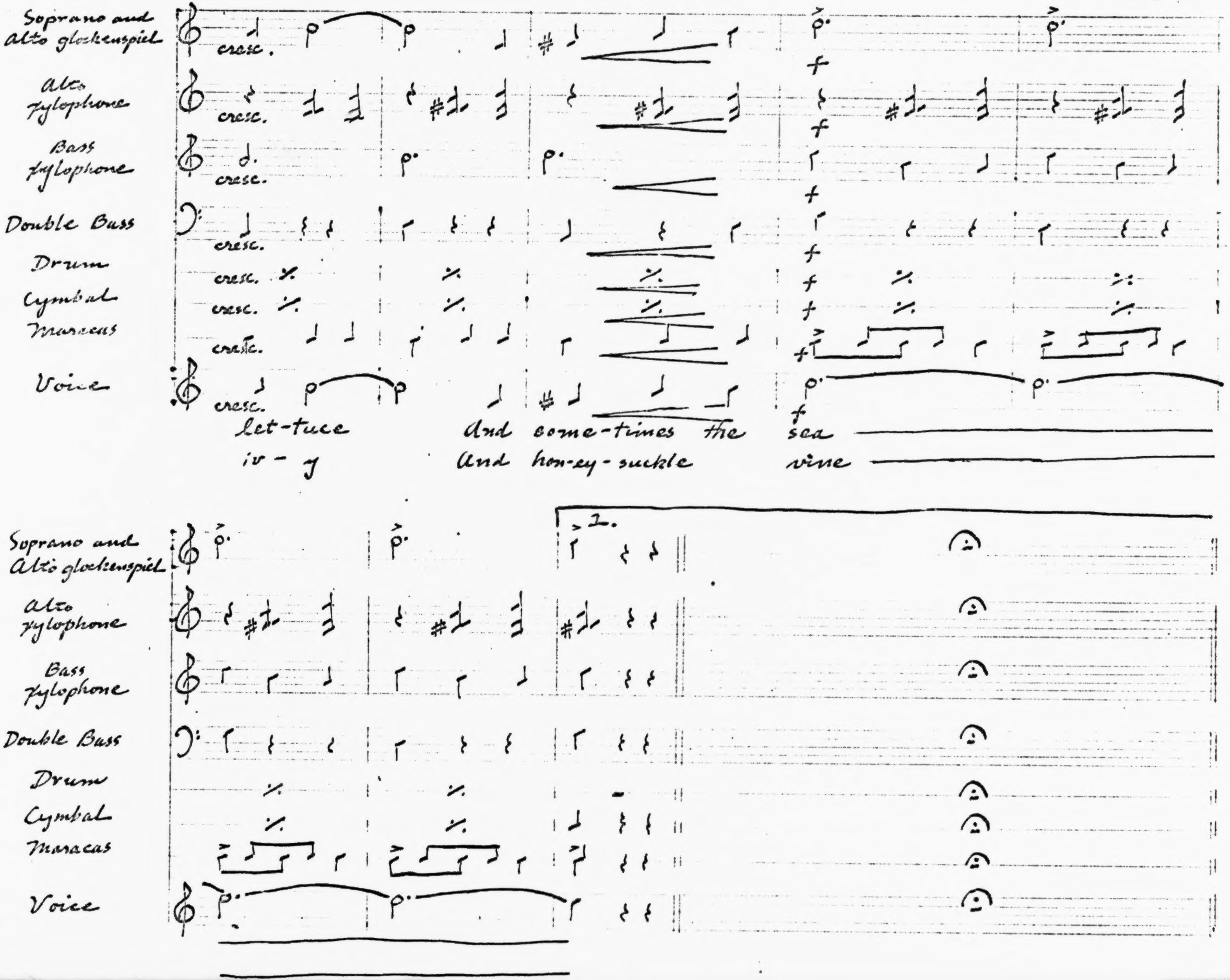
Without using any scenery, we imagined ourselves in a cool green park. The music helped to create this atmosphere, and the different little sound effects, such as the trickle of water, made scenery unnecessary. Simplicity was the keynote. A good imagination can place you anywhere, and to develop this faculty in children constructively, and to keep it alive is doing them a great service.

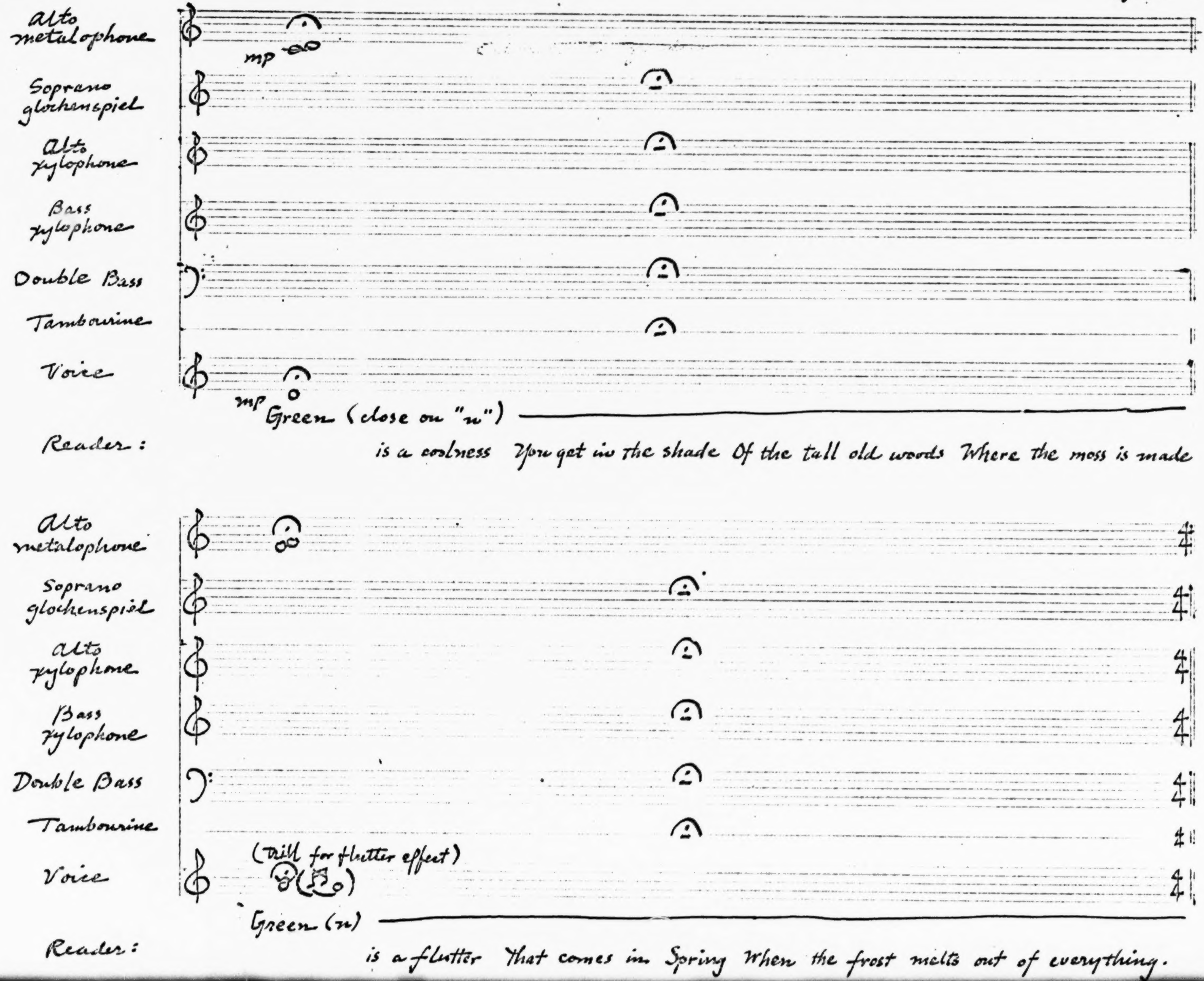
What is Green?

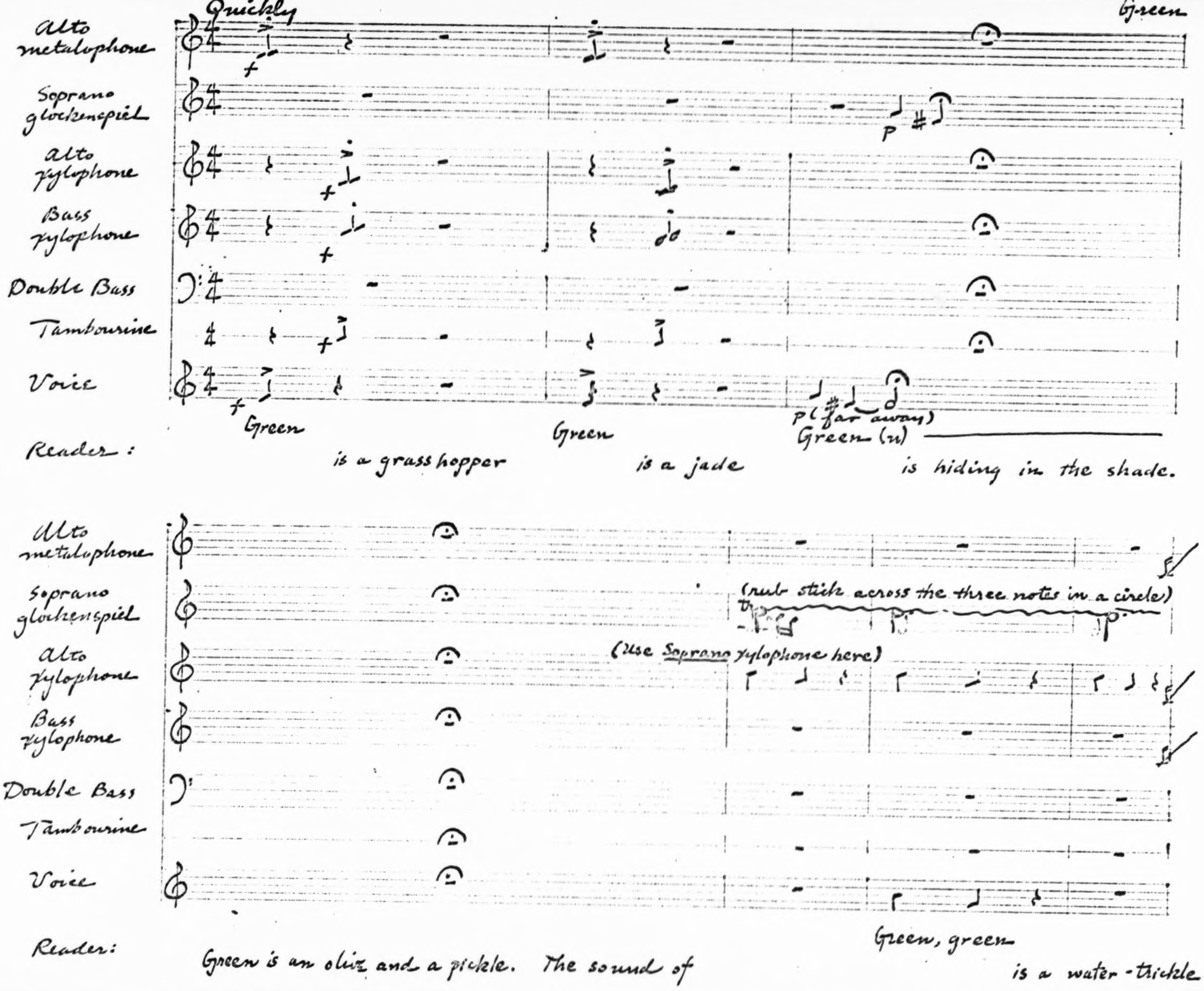
Poem: Mary O'Neill

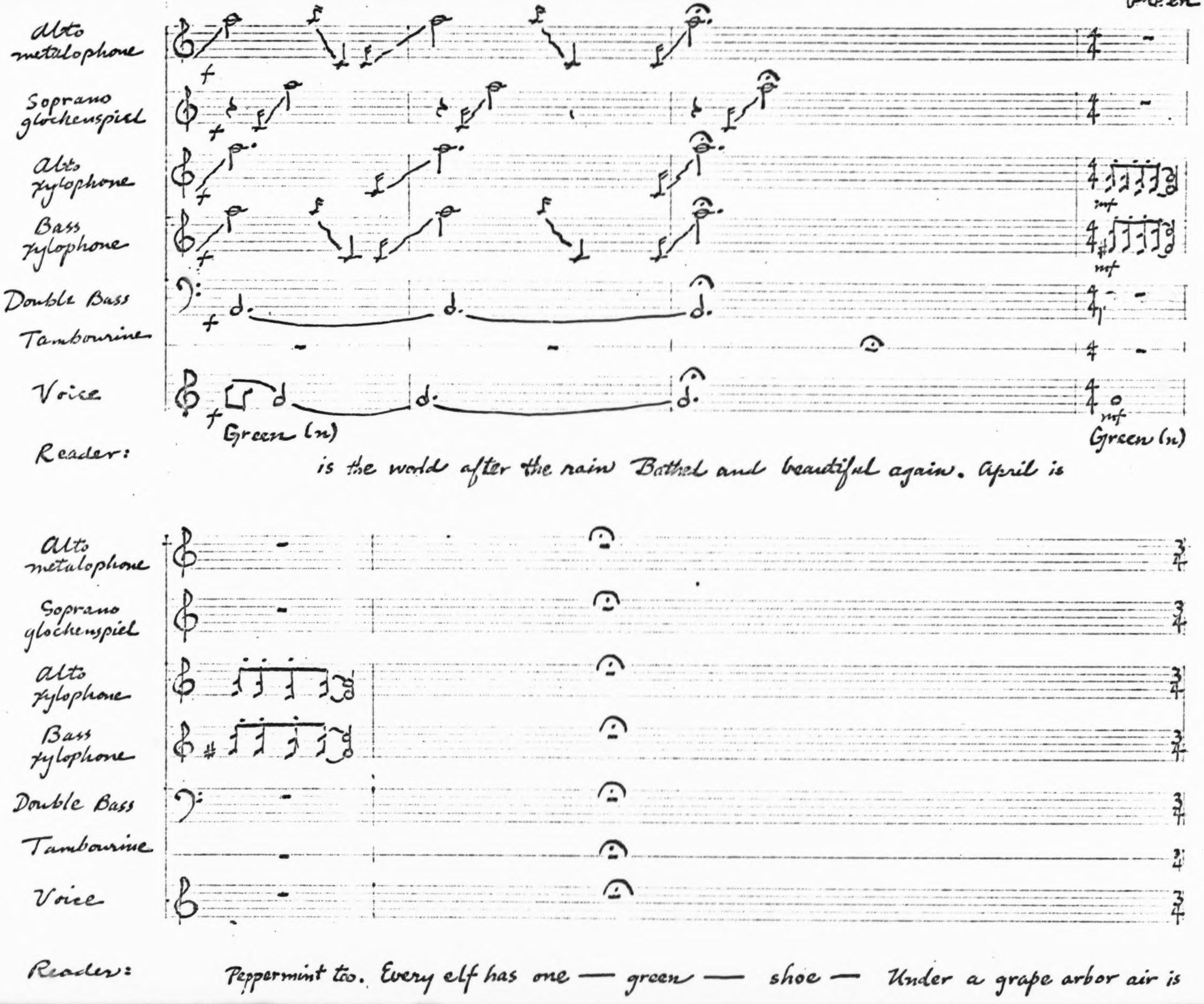
Music: Sister Jeremy, S.L.

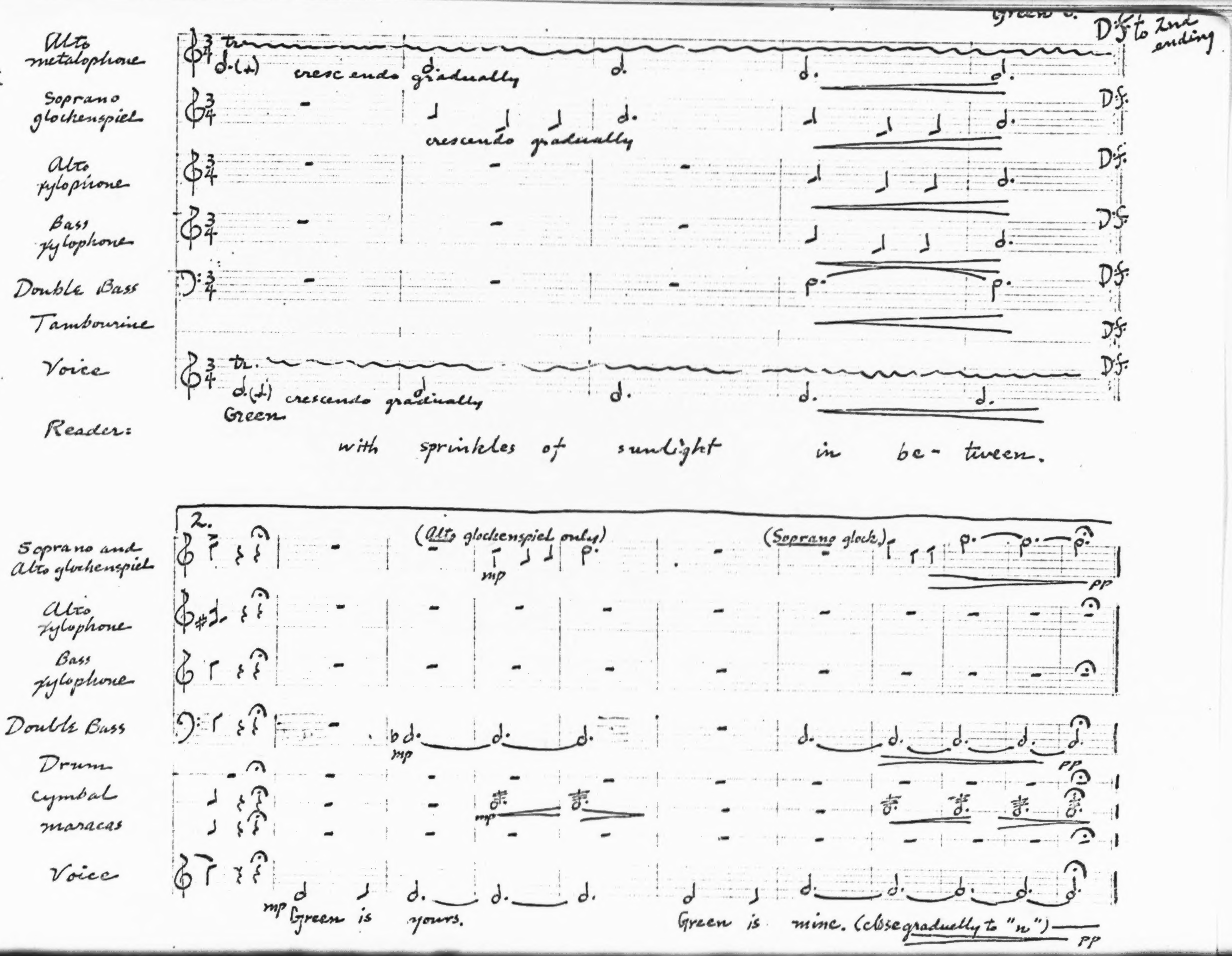

Gay and in a lilting waltz tempo
Soprano and Alto glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Snare or Hand Drum
Cymbal (brush)
Maracas
Voice
Right
Left
mf
1. Green is the grass and the leaves of
2. Green is the meadow Green is the
trees
Green is the smell of a coun-try breeze
Green is


Soprano and Alto glockenspiel
Alto Xylophone
Bass Xylophone
Double Bass
Drum
Cymbal
Maracas
Voice
cresc.
f
let-tuce
And some-times the
sea
iv - y
And hon-ey-suckle
vine
1.


Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
Reader:
mp
mp
Green (close on "n")
is a coolness You get in the shade Of the tall old woods Where the moss is made
Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
Reader:
(Trill for flutter effect)
Green (n)
is a flutter That comes in Spring When the frost melts out of everything.


Quickly
Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
f
p
p (far away)
Green
Green
Green (n)
Reader:
is a grasshopper
is a jade
is hiding in the shade.
Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
(rub stick across the three notes in a circle)
(Use Soprano xylophone here)
Green, green
Reader:
Green is an oliv and a pickle. The sound of
is a water-trickle


Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
f
mf
Green (n)
Green (n)
Reader:
is the world after the rain Bathed and beautiful again. April is
Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
Reader:
Peppermint too. Every elf has one — green — shoe — Under a grape arbor air is


Alto metalophone
Soprano glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Tambourine
Voice
Reader:
tr
crescendo gradually
crescendo gradually
D.S.
D.S. to 2nd ending
Green
with sprinkles of sunlight in be- tween.
2.
Soprano and Alto glockenspiel
Alto xylophone
Bass xylophone
Double Bass
Drum
cymbal
maracas
Voice
(Alto glockenspiel only)
(Soprano glock.)
mp
pp
Green is yours.
Green is mine. (close gradually to "n")

BLACK

Speech-wise, music-wise, dance-wise, this color seemed made for the older boys. At first they were to do the whole thing, but as time went on, it was obvious that a contrast was needed between the staccato and legato style of the piece. The girls provided this, and the result was just what we wanted.

The speech section was done by one boy alternating with the boys group. It was done in a quick, staccato fashion accompanied by percussion instruments. The melody line, which was smooth and restful, was sung by the girls.

The choreography for the first part was in the WEST SIDE STORY fashion; for the second part, in the style of modern ballet. Again, the interpretation was pretty much left up to the children. I did find, however, that some help needed to be given to the boys because, at this age level, they are somewhat embarrassed and need a bit of encouragement to overcome inhibitions of dancing in front of other boys. However, since most of them had seen WEST SIDE STORY, it was not the problem it could have been.

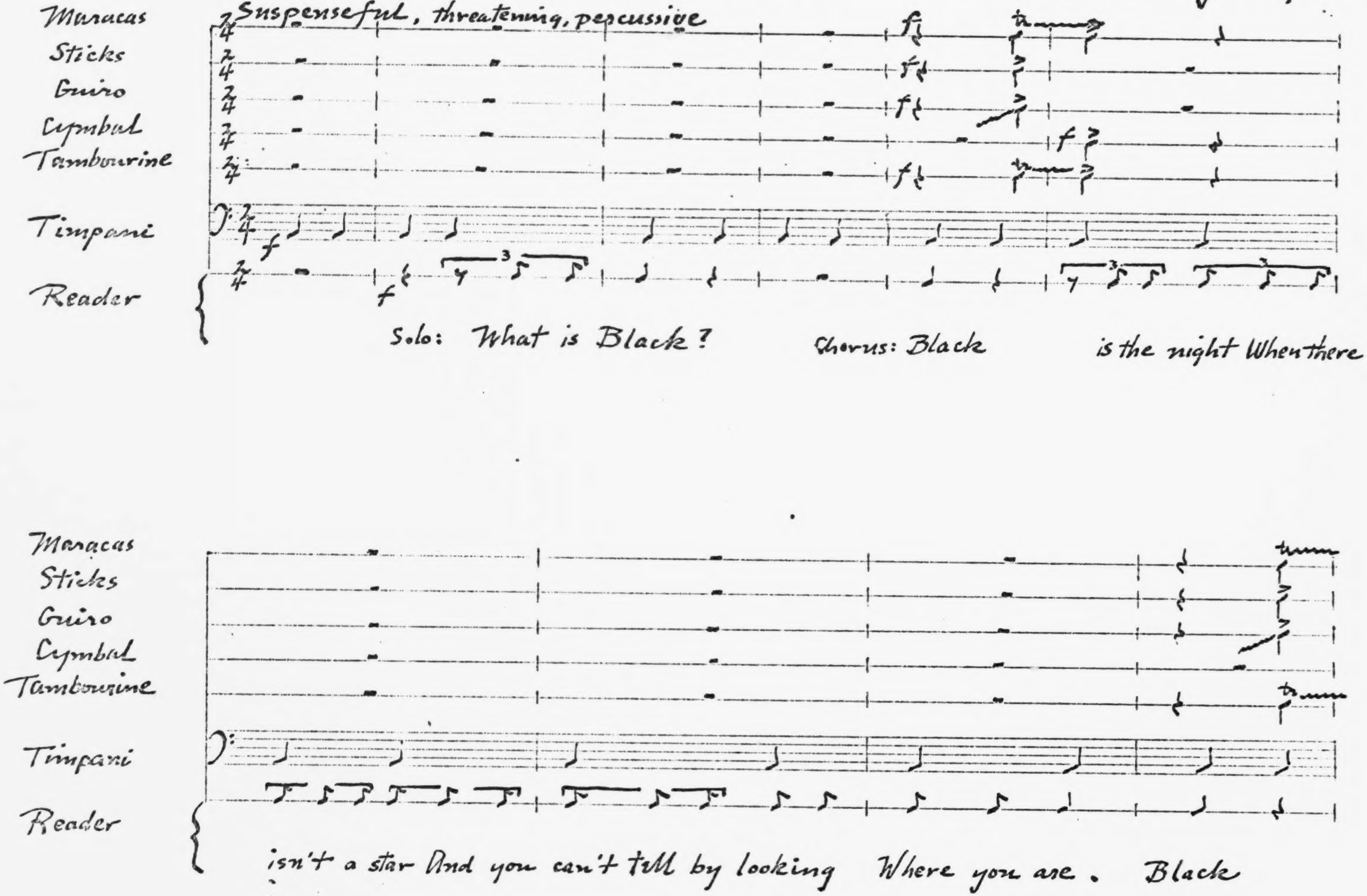
The staging for this was most effective. The children performed in front of a black curtain, the boys in dark clothes, the girls in black leotards. The positions of the boys were abstract and angular; that of the girls, relaxed and graceful. All the way through there was a nice combination of tension and relief.

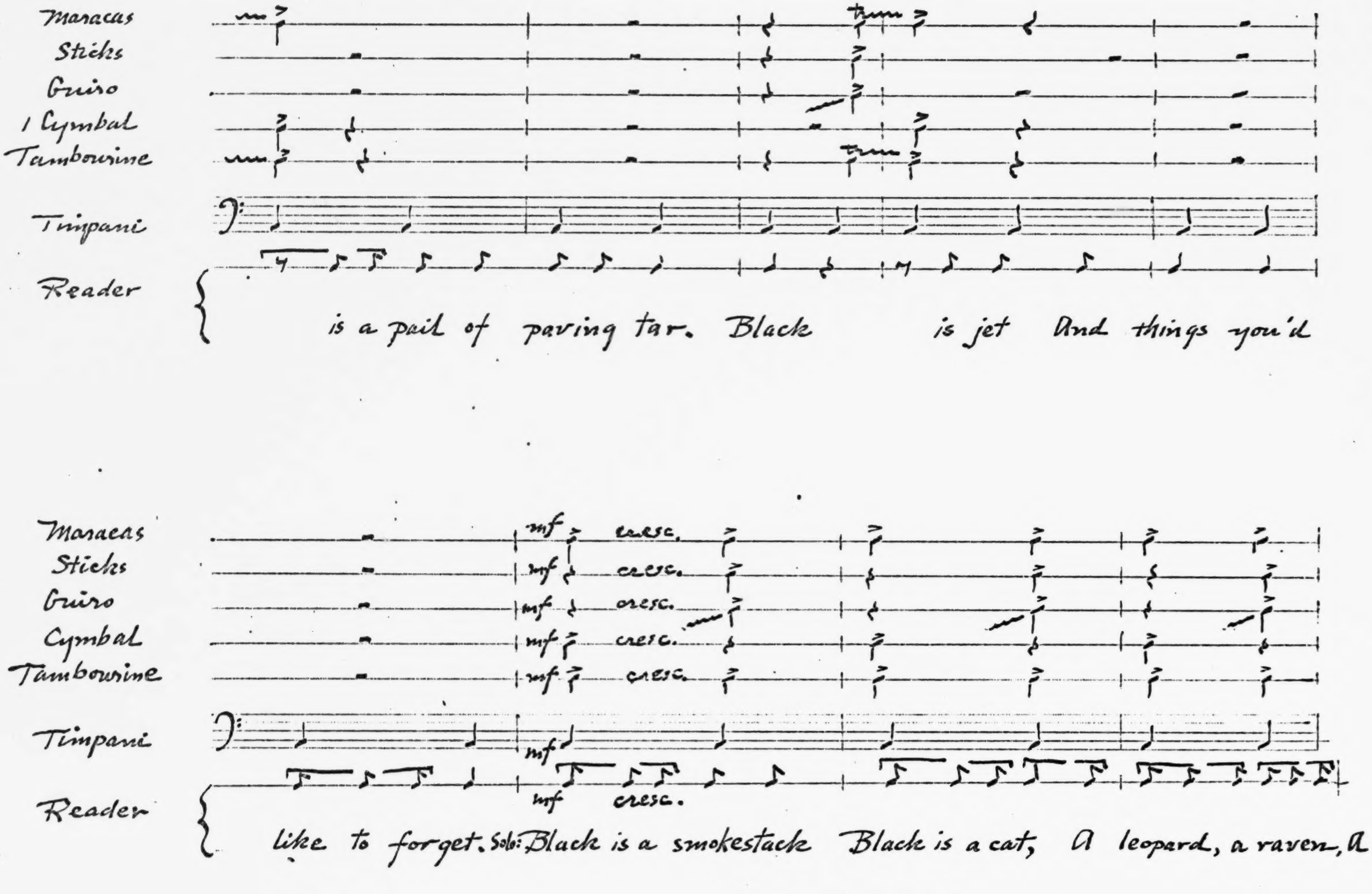
This color was the most difficult to do, and ideas changed from day to day. Up until the final performance, I did not know exactly what to expect, but when the boys finally took the stage and were under the spotlight, they cam through admirably.

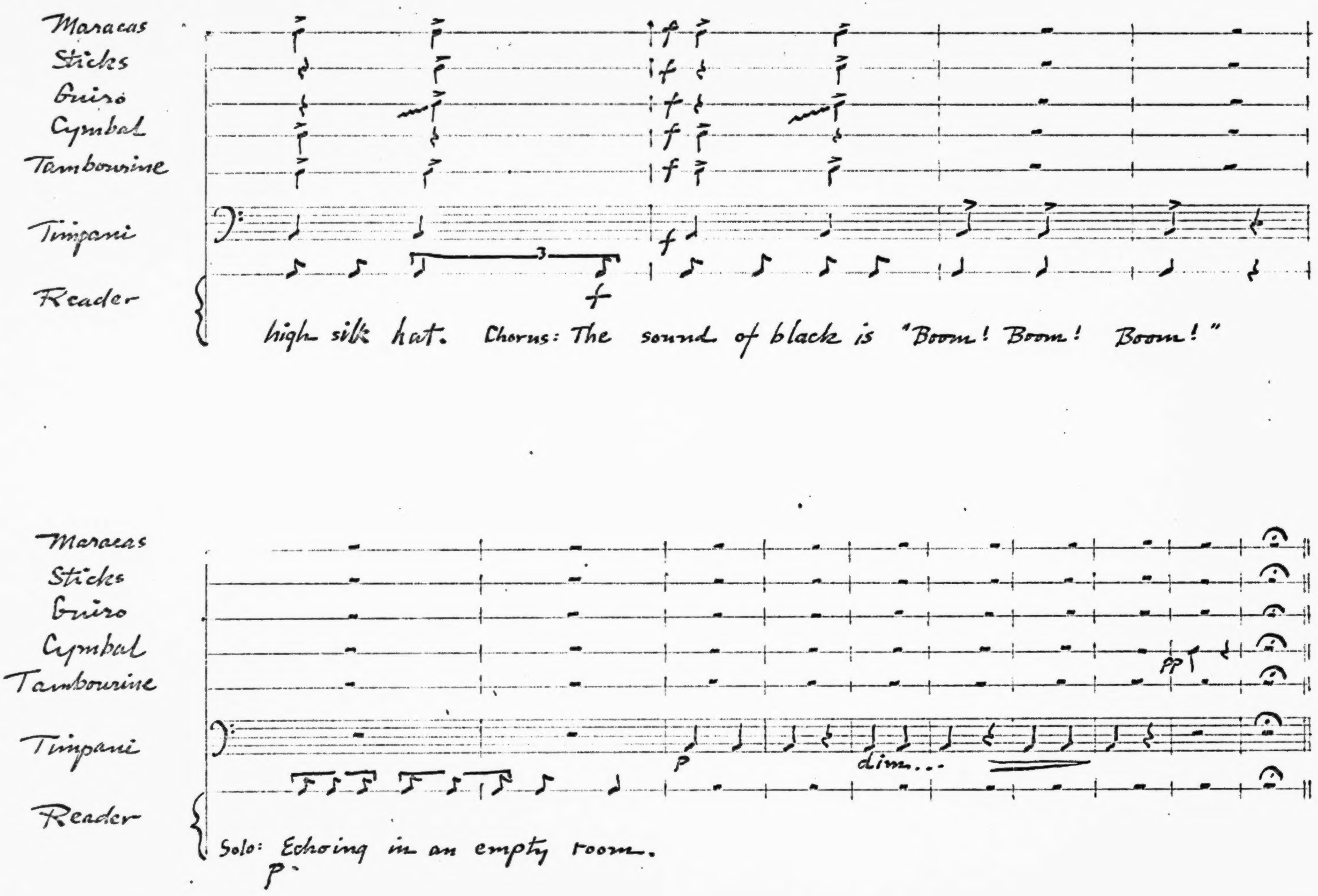
What is Black?

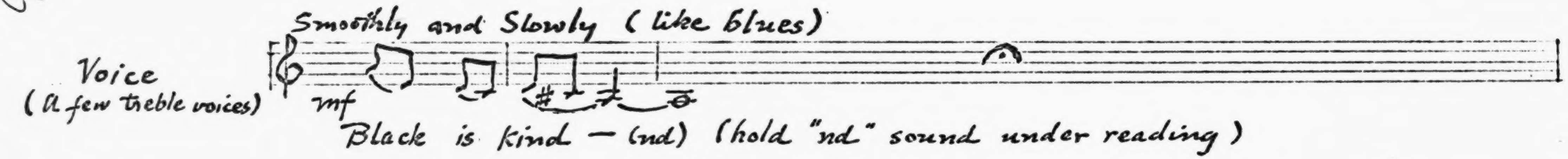
Poem: Mary O'Neill

Music: Sister Jeremy, S.L.

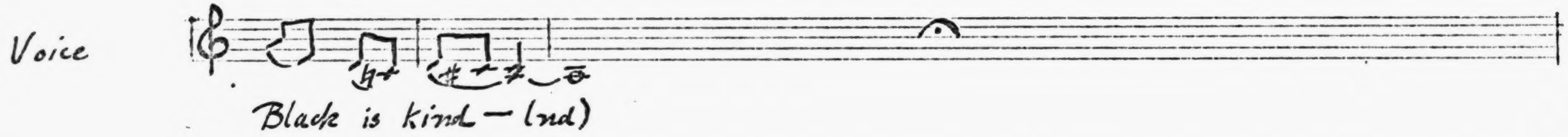

Suspenseful, threatening, percussive
Maracas
Sticks
Guiro
Cymbal
Tambourine
Timpani
Reader
f
3
Solo: What is Black?
Chorus: Black
is the night When there
isn't a star And you can't tell by looking
Where you are. Black


Maracas
Sticks
Guiro
1 Cymbal
Tambourine
Timpani
Reader
is a pail of paving tar. Black is jet And things you'd
Maracas
Sticks
Guiro
Cymbal
Tambourine
Timpani
Reader
mf
cresc.
like to forget. Solo: Black is a smokestack Black is a cat, A leopard, a raven, A

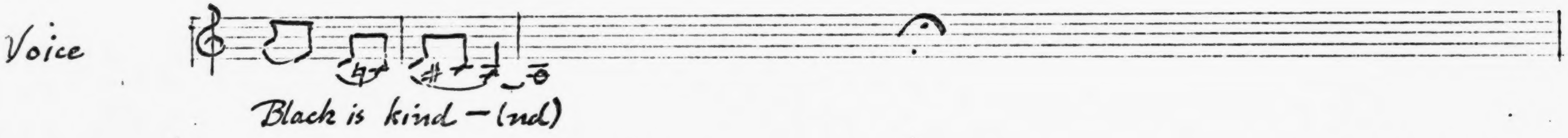

Maracas
Sticks
Guiro
Cymbal
Tambourine
Timpani
Reader
f
3
f
high silk hat. Chorus: The sound of black is "Boom! Boom! Boom!"
Maracas
Sticks
Guiro
Cymbal
Tambourine
Timpani
Reader
p
dim...
pp
Solo: Echoing in an empty room.
p


Smoothly and Slowly (like blues)
Voice
(A few treble voices)
mf
Black is kind — (nd) (hold "nd" sound under reading)

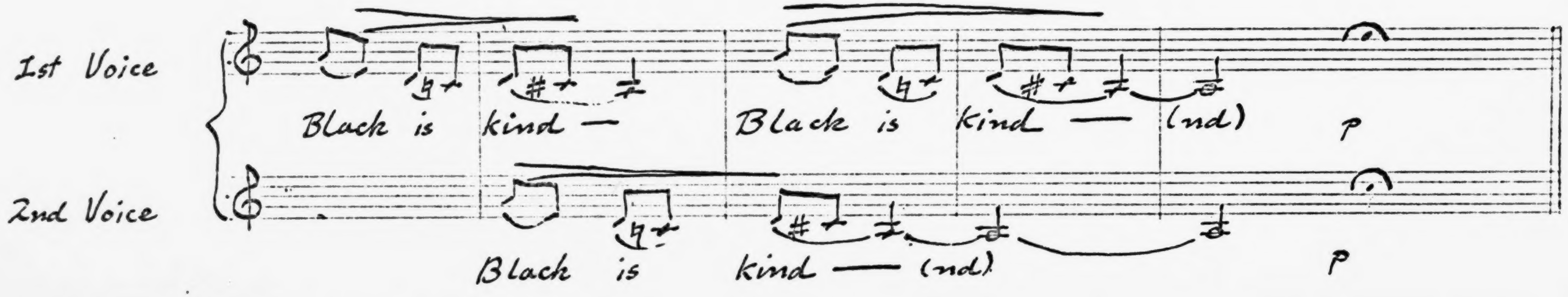
Reader (freely)Solo: It covers up The run-down street, The broken cup.

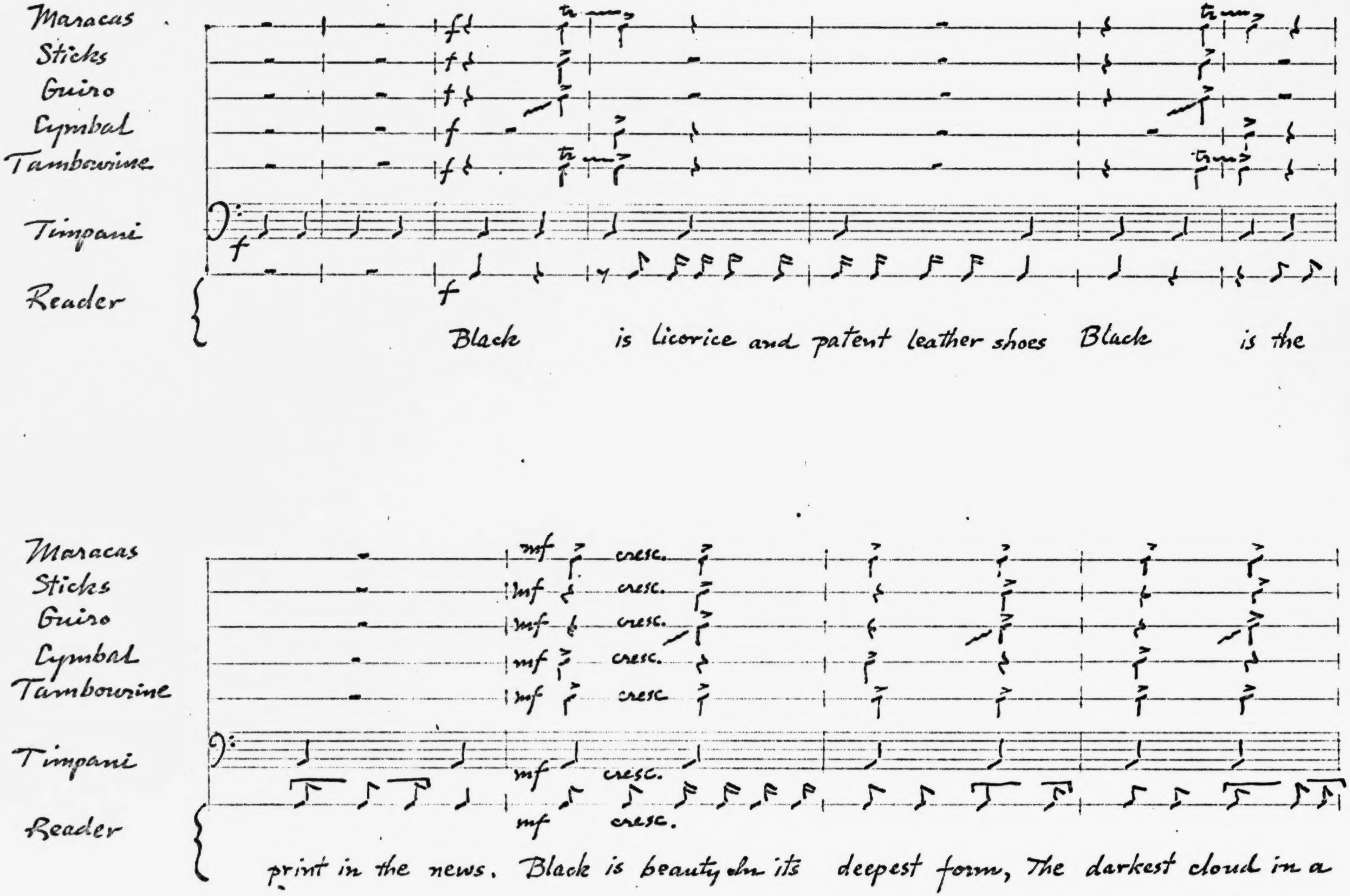

Voice
Black is kind — (nd)

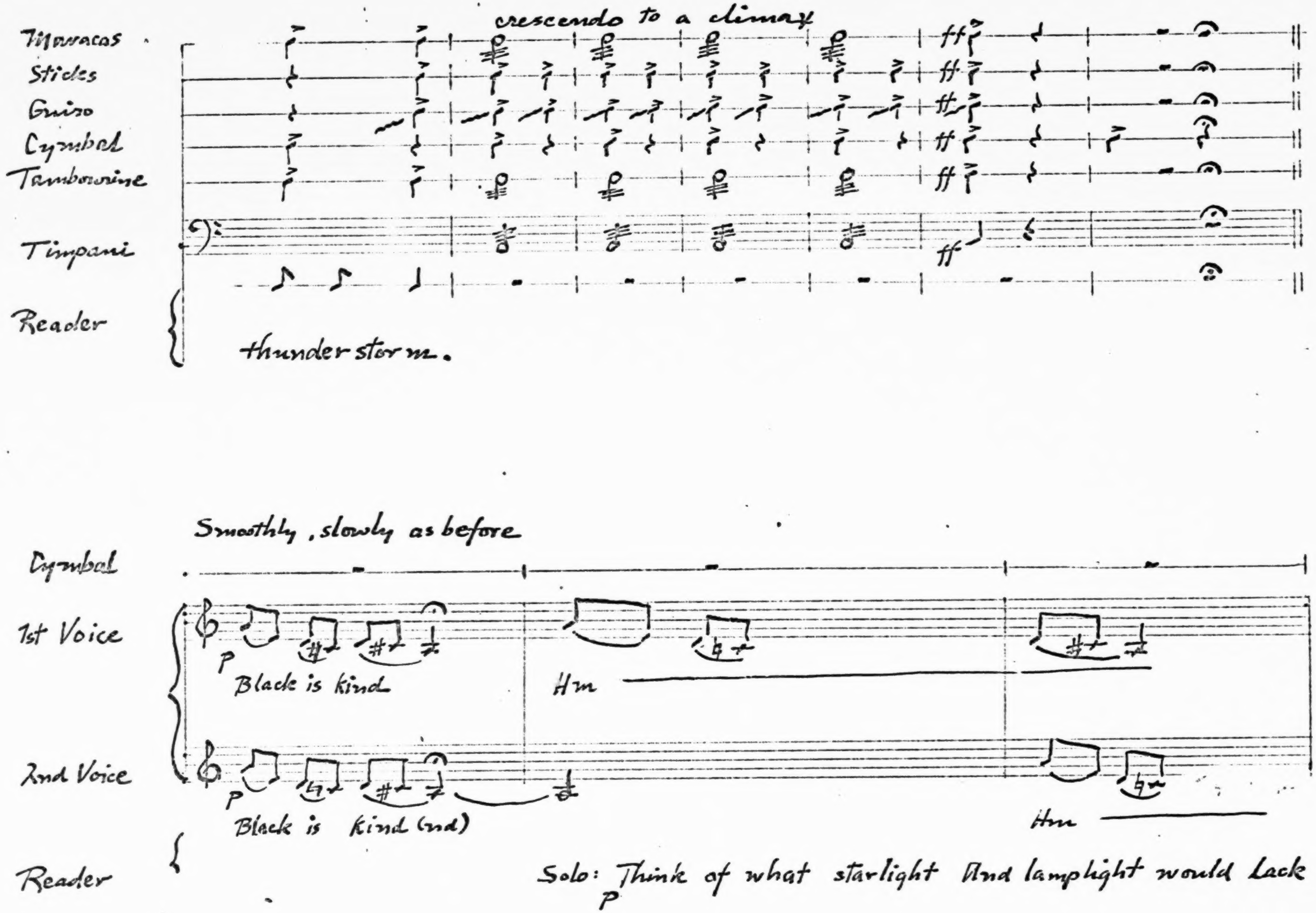
Reader Black is charcoal And patio grill, The soot spots on The window sill.


Voice
Black is kind — (nd)

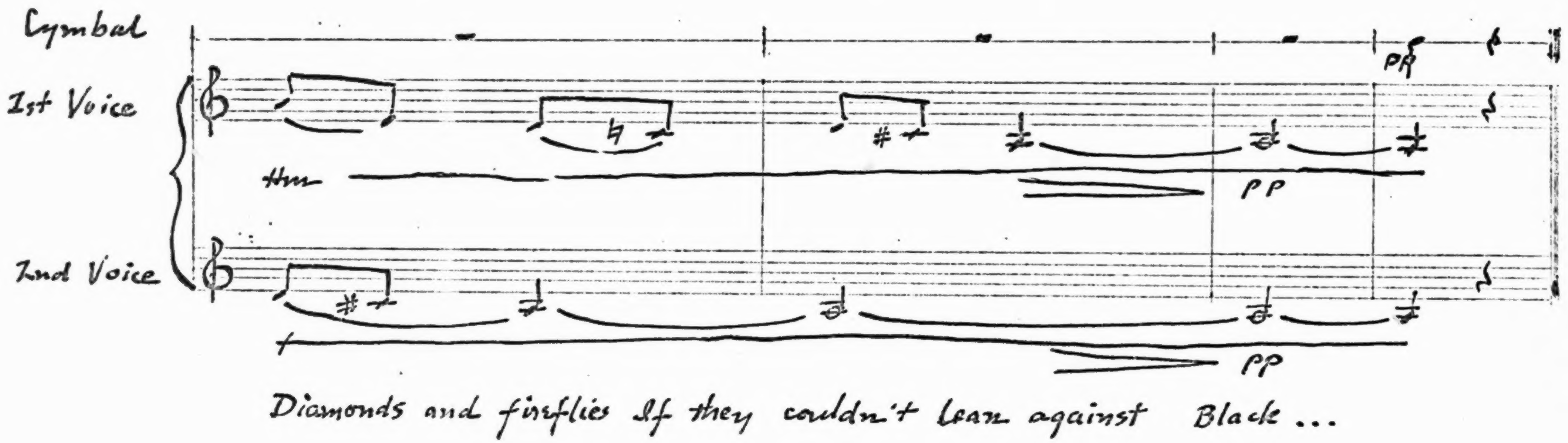
Reader Black is a feeling Hard to explain Like suffering but Without the pain.


1st Voice
Black is kind — Black is kind — (nd)
p
2nd Voice
Black is kind — (nd)
p


Maracas
Sticks
Guiro
Cymbal
Tambourine
Timpani
Reader
f
tr
Black is licorice and patent leather shoes Black is the
mf
cresc.
print in the news. Black is beauty in its deepest form, The darkest cloud in a


crescendo to a climax
Maracas
Sticks
Guiro
Cymbal
Tambourine
Timpani
Reader
ff
thunderstorm.
Smoothly, slowly as before
Cymbal
1st Voice
2nd Voice
Reader
p
Black is kind
Hm
Black is kind (nd)
Hm
Solo: Think of what starlight And lamplight would Lack

Black 7.


Cymbal
1st Voice
2nd Voice
Hm
PP
PP
PP
Diamonds and fireflies If they couldn't lean against Black ...

YELLOW

Yellow is a happy, bouncy color. A fun color. And this is exactly what we had in doing this one. The word, "Happiness," was used often in the composition, so yellow became our happiness color. Then, too, many yellow things in nature such as daffodils, sun, canaries, are signs of life and joy.

A group of fifth, sixth, and seventh graders did this one. Four contrasting solo voices were used along with the group. One voice, that of a girl, was bouncy, light, and cheery. Another voice, a boy's, had the accent of a farmer of the middle west. The third voice was that of a southern belle, and the fourth voice was one that had a smooth, silky quality for the line, "The cream on top of Jersey milk."

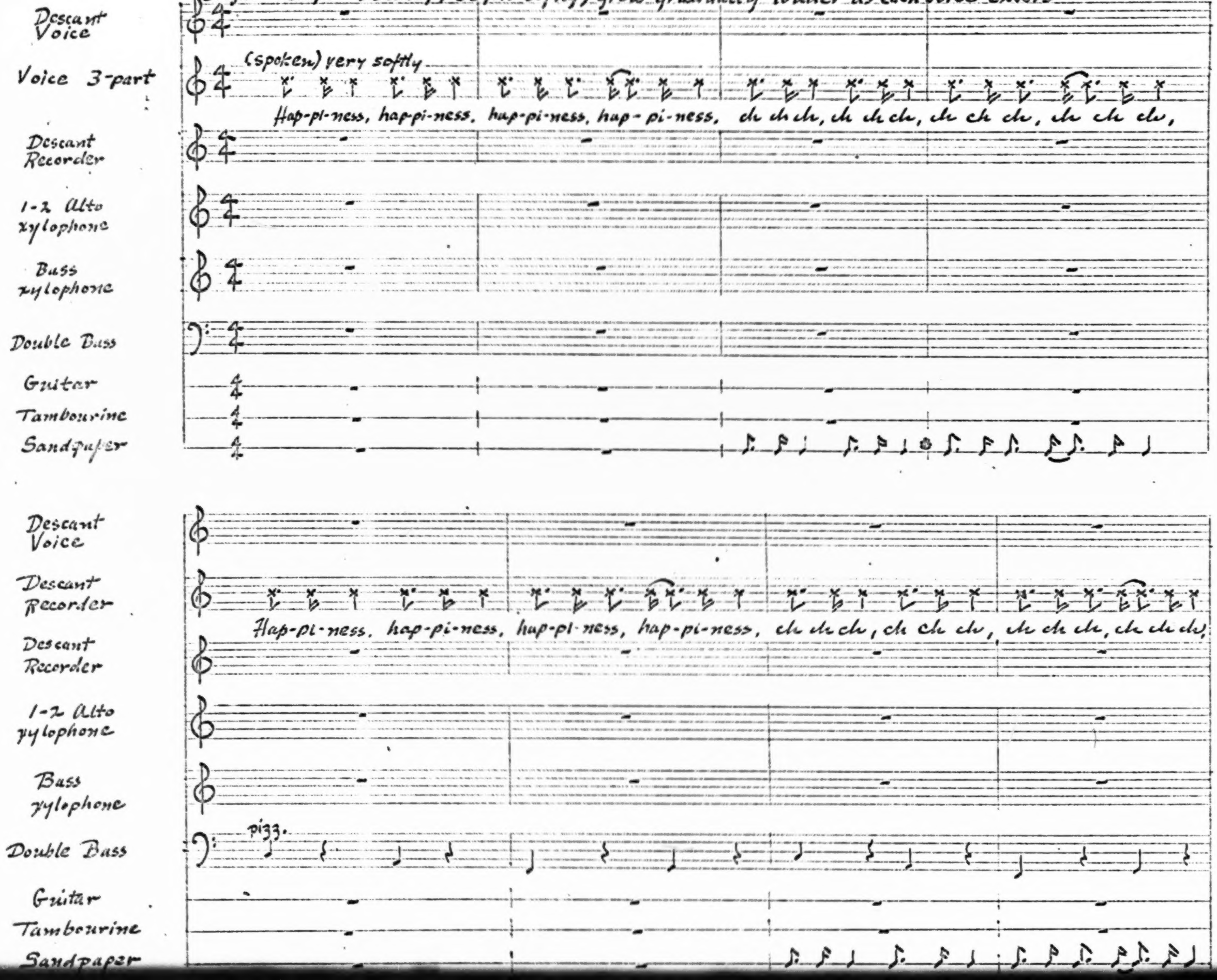
This piece alternated between the saying of lines and the singing of lines which meant the children had to develop their sense of pitch in order to come in on the right note. It also made use of unison singing, and two part and three part harmony. It moved quickly, and throughout the whole composition, the children kept a rhythmical, bouncing motion which added much to general atmosphere. This, together with the fact that they were dressed in various shades of yellow under a yellow light, and were beaming from ear to ear, diffused a glow among the audience. We performed this one last because it left one with just the right feeling, a happiness feeling.

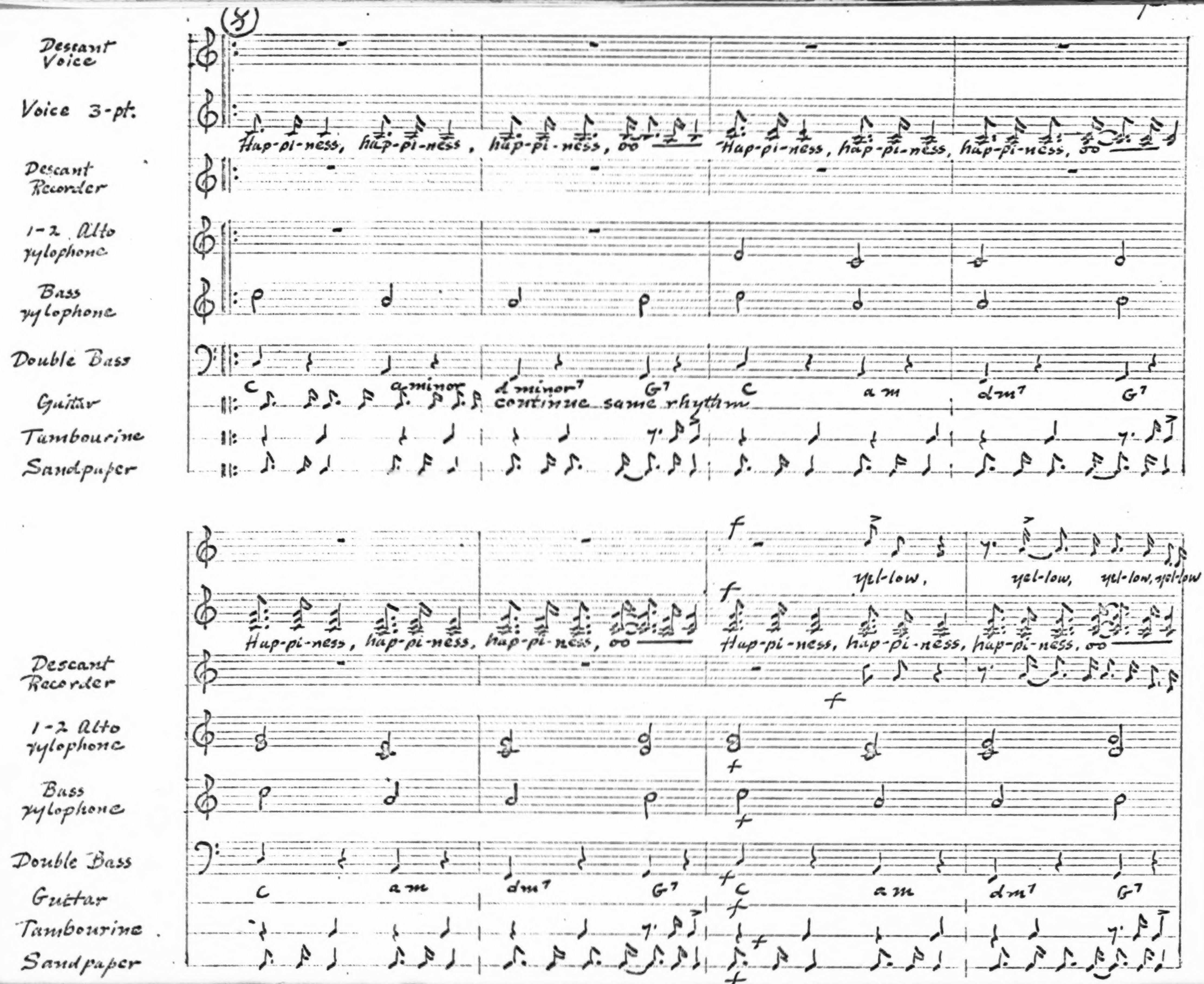
Poem: Mary O'Neill

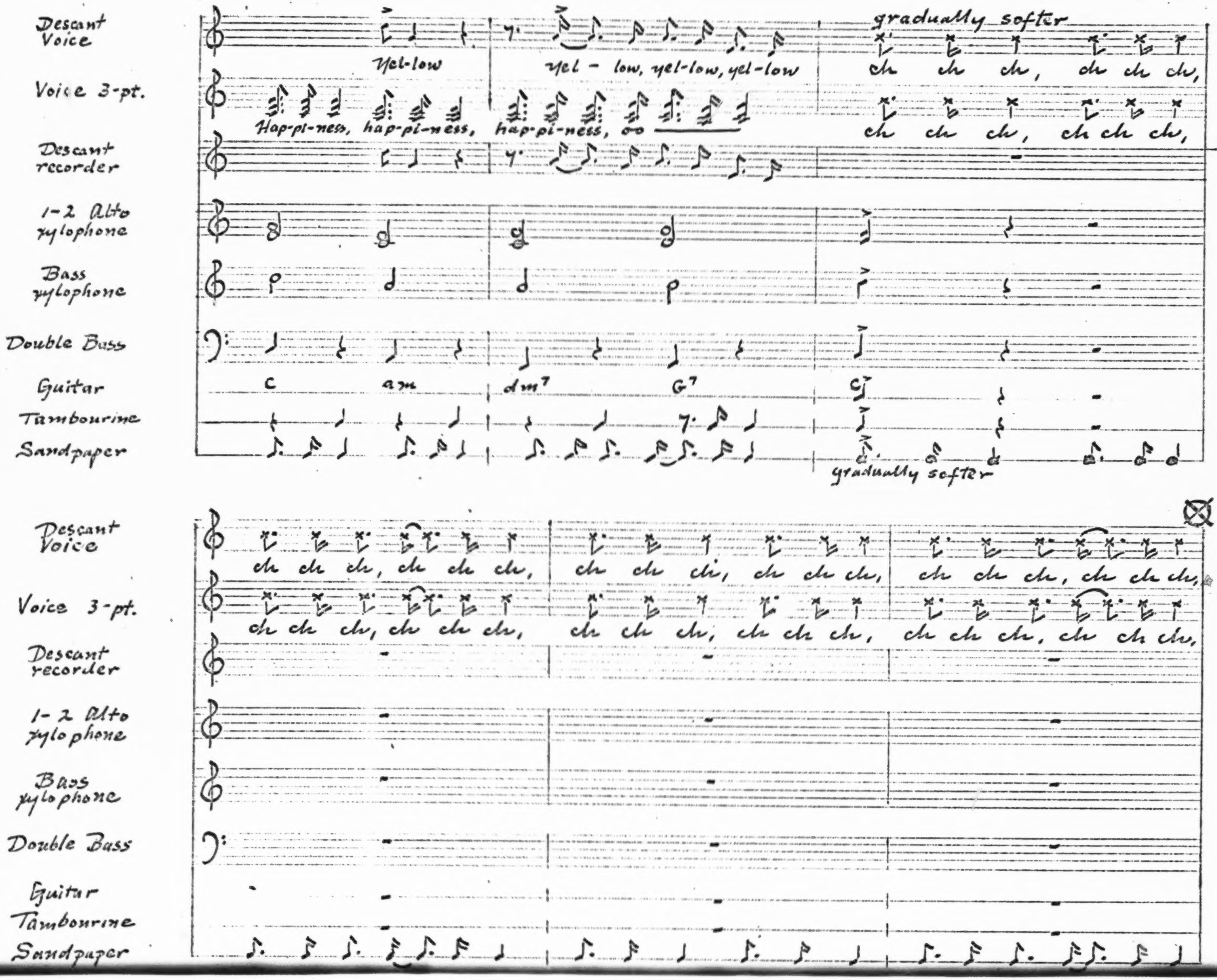
What is Yellow?

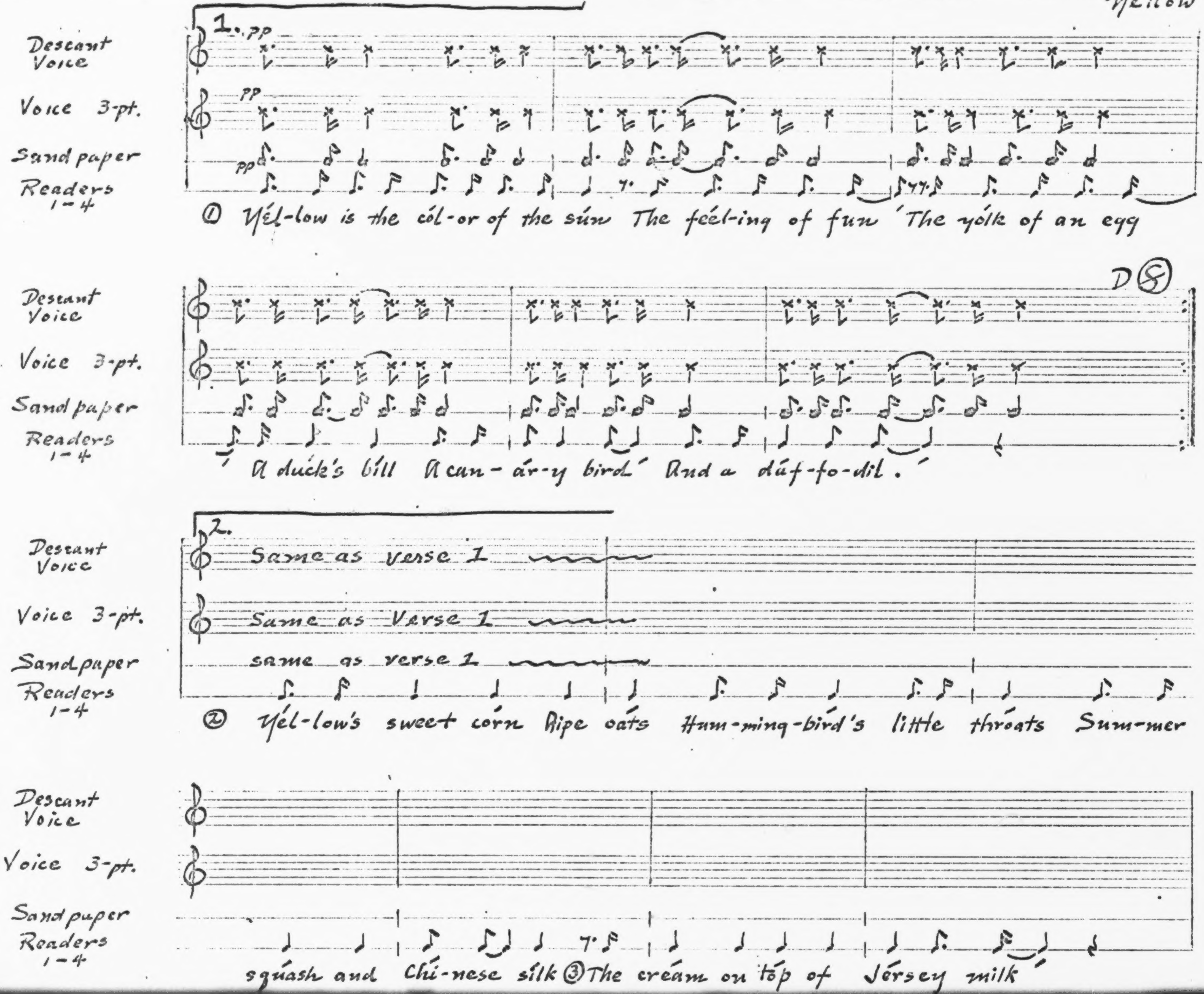
Music: Sister Jeremy, S.L.

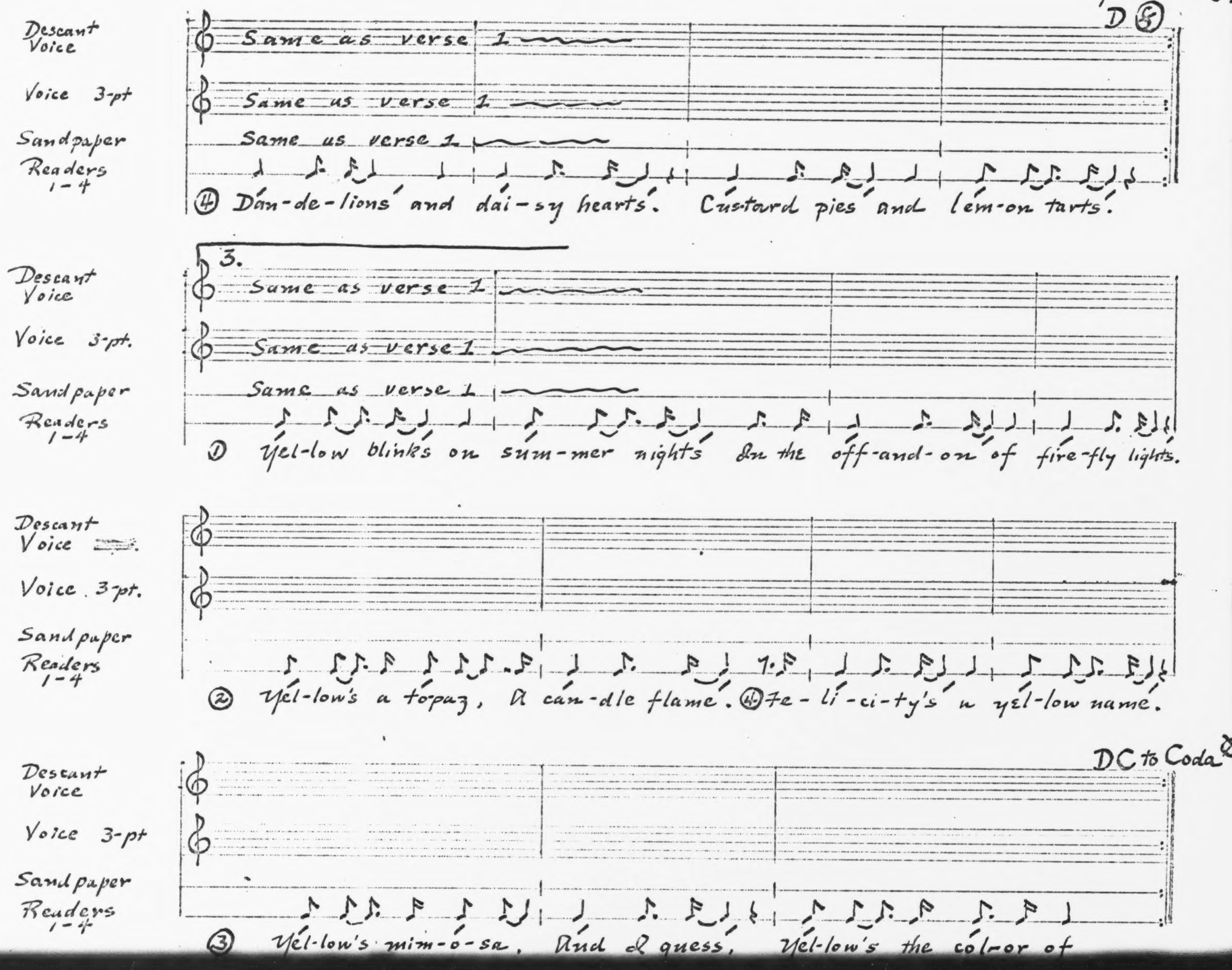
Bright Tempo: bouncy; begin softly, grow gradually louder as each voice enters


Descant Voice
Voice 3-part
(spoken) very softly
Hap-pi-ness, hap-pi-ness, hap-pi-ness, hap-pi-ness, ch ch ch, ch ch ch, ch ch ch, ch ch ch,
Descant Recorder
1-2 Alto xylophone
Bass xylophone
Double Bass
Guitar
Tambourine
Sandpaper
Descant Voice
Descant Recorder
Hap-pi-ness, hap-pi-ness, hap-pi-ness, hap-pi-ness, ch ch ch, ch ch ch, ch ch ch, ch ch ch,
Descant Recorder
1-2 Alto xylophone
Bass xylophone
Double Bass
pizz.
Guitar
Tambourine
Sandpaper

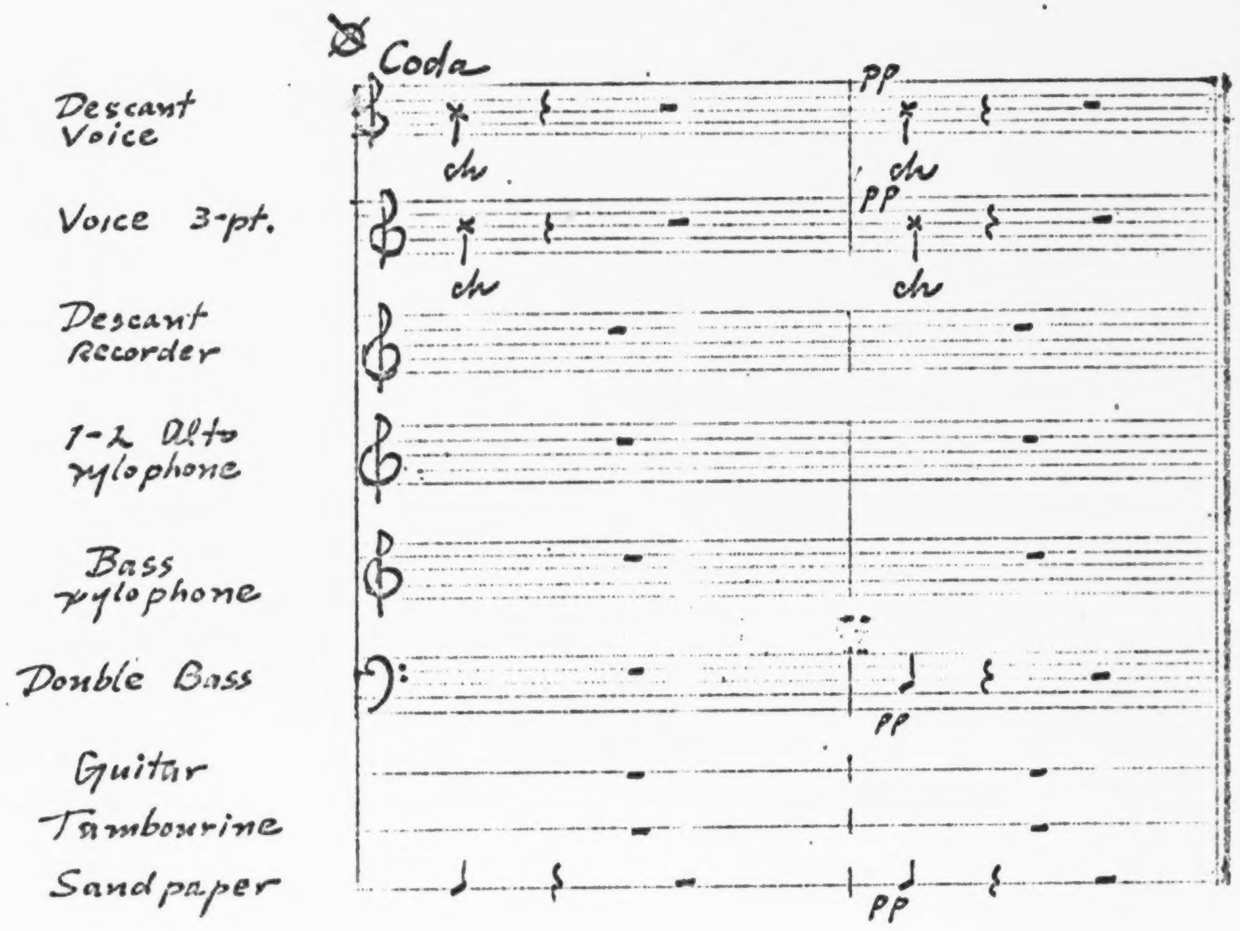

8
Descant Voice
Voice 3-pt.
Descant Recorder
1-2 Alto xylophone
Bass xylophone
Double Bass
Guitar
Tambourine
Sandpaper
Hap-pi-ness, hap-pi-ness, hap-pi-ness, oo
Hap-pi-ness, hap-pi-ness, hap-pi-ness, oo
C
a minor
d minor7
G7
continue same rhythm
C
am
dm7
G7
Descant Recorder
1-2 Alto xylophone
Bass xylophone
Double Bass
Guitar
Tambourine
Sandpaper
f
yel-low,
yel-low,
yel-low, yel-low
Hap-pi-ness, hap-pi-ness, hap-pi-ness, oo
Hap-pi-ness, hap-pi-ness, hap-pi-ness, oo
C
am
dm7
G7
C
am
dm7
G7


Descant Voice
Voice 3-pt.
Descant recorder
1-2 Alto xylophone
Bass xylophone
Double Bass
Guitar
Tambourine
Sandpaper
Yel-low
yel - low, yel-low, yel-low
gradually softer
ch ch ch, ch ch ch,
Hap-pi-ness, hap-pi-ness, hap-pi-ness, oo
ch ch ch, ch ch ch,
C
am
dm7
G7
C
gradually softer
ch ch ch, ch ch ch, ch ch ch, ch ch ch, ch ch ch, ch ch ch,
ch ch ch, ch ch ch, ch ch ch, ch ch ch, ch ch ch, ch ch ch,


1.
pp
Descant Voice
Voice 3-pt.
Sandpaper
Readers 1-4
① Yél-low is the cól-or of the sún The féel-ing of fun 'The yólk of an egg
' A dúck's bill A can-ár-y bird' And a dáf-fo-dil.'
D.S.
2.
Same as verse 1
Same as Verse 1
same as verse 1
② Yél-low's sweet corn Ripe oats Hum-ming-bird's little throats Sum-mer
squash and Chi-nese silk ③ The cream on tóp of Jérsey milk'


D 𝄋
Descant Voice
Voice 3-pt
Sandpaper Readers 1-4
Same as verse 1
Same us verse 1
Same us verse 1
④ Dán-de-lions and dai-sy hearts. Cústard pies and lém-on tarts.
3.
Descant Voice
Voice 3-pt.
Sandpaper Readers 1-4
Same as verse 1
Same as verse 1
Same as verse 1
① Yél-low blinks on súm-mer nights In the óff-and-on of fíre-fly lights.
Descant Voice
Voice 3-pt.
Sandpaper Readers 1-4
② Yél-low's a tópaz, A cán-dle flame. ④ Fe-lí-ci-ty's a yél-low name.
DC to Coda
Descant Voice
Voice 3-pt
Sandpaper Readers 1-4
③ Yél-low's mim-ó-sa, And I guess, Yél-low's the cól-or of

Yellow 6.


Coda
Descant Voice
Voice 3-pt.
Descant Recorder
1-2 Alto xylophone
Bass xylophone
Double Bass
Guitar
Tambourine
Sandpaper
pp
ch
pp
ch
ch
ch
pp
pp

Even Flies Remember

some suggestions for heredity experiments with the house fly . . .

His
wisdom
ted the
Fly
THEN FORGOT
US WHY
Nash

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by Paul D. Merrick
Webster College
Webster Groves, Missouri 63119

A publication of the Webster Institute of Mathematics Science and Arts (WIMSA), Webster College, Webster Groves, Missouri. This work was supported in part by a grant from the Carnegie Foundation.

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PREFACE

Even Flies Remember is the third in a series of WIMSA publications on the house fly. The first two, On the Fly (husbandry techniques) and The Fly Cycle (film commentary), together with the classroom film, "A Linear Look at the Fly", form a package intended for use with in-service elementary school teachers. Even Flies Remember is broader in scope than On the Fly, containing information and ideas which go considerably beyond what might be judged "fare" for the intermediate grades. In building the theme of this document we have drawn upon multiple experiences at different levels. The basic genetic crosses were carried out by fifth graders; the idea of "keying" supplementary information to classroom experiments comes from the Continuous Laboratory notion developed for the college freshman biology course and the Master of Arts in Teaching program at Webster. Some of the more specialized experiments and discussions toward the end of the document reflect interactions in the college genetics course and/or research being carried on in the WIMSA fly laboratory. The result of this wide-spectrum input, we hope, is an omnibus document, serving as a guide for heredity studies with the house fly in the intermediate grades, a nucleus for teacher training materials, and perhaps a "skeleton" for in-depth laboratory work in secondary schools.

The basic experimental work on genetic crosses with house flies was carried out with the indispensable aid of eight fifth graders from the Webster College Experimental School. These youngsters, having mastered the husbandry techniques described in On the Fly, continued on for six more weeks, making specific crosses of selected house fly strains and observing the results over two generations. These youngsters have "lived" through three years of experimental teaching in the development of WIMSA science materials. During that time they have provided all of us with rich, and sometimes unique, pedagogical experiences. They are: Kim Baker, Damian Burke, Louis Ferrario, Judy Knoop, Tom Gale, Denise Timmerman, Kim Olzewski and Kathy Williams. They have left a permanent record of their perceptiveness, intellectual honesty and respect for one another's minds and persons in the classroom films "Mendel Revisited" and "Building Genetic Models".

I would like to express my thanks to the many people who contributed, both directly and indirectly, to Even Flies Remember. Two Webster College students, Miss Diane Dignam and Mrs. Helen Eckelkamp, did the bulk of the experimental teaching, guiding the children through the work with a "light touch". Dr. Robert Sokal of the University of Kansas and Dr. Wendell Kilgore of the University of California at Davis provided the house fly strains used in this work. In addition, Dr. Sokal read a draft of the manuscript and made suggestions for its improvement. Mrs. Geraldine McKelvey typed the manuscript; and Miss Jackie Dotta, a Webster student, provided editorial assistance. I am particularly grateful to Sister Marie Francis Kenoyer, Director of WIMSA, for her support and encouragement in the development of this work.

Paul D. Merrick

Webster College
April 28, 1967

INTRODUCTION

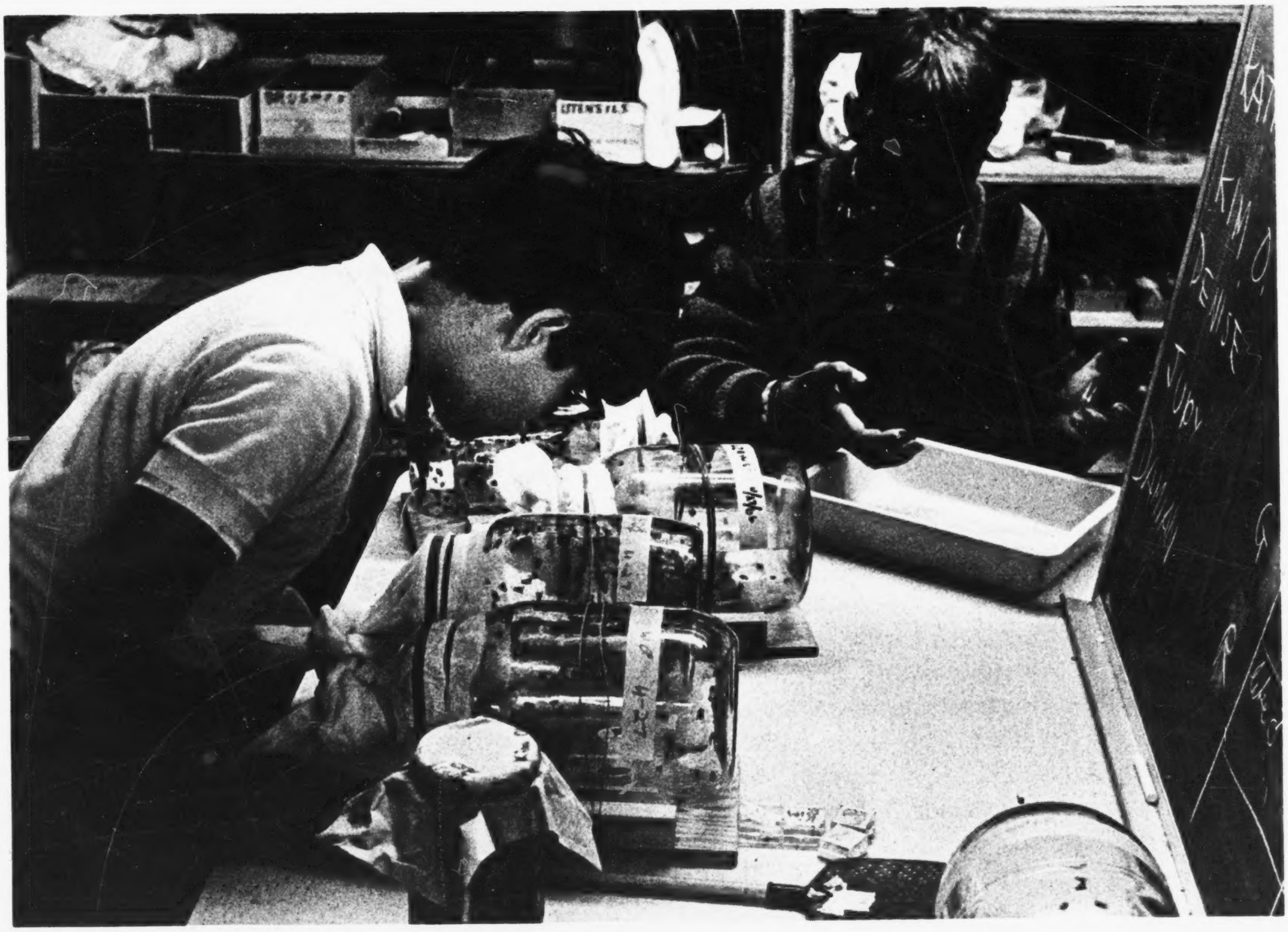
KIM O.
DENISE
JUDY
DAMIAN
UTENSILS

Figure 1

Even Flies Remember is about heredity in general and heredity in the house fly in particular. It is not, however, intended as a short course in genetics..... or a long one for that matter. Basically the guide is concerned with the mechanics of making a genetic cross between two different house fly strains, one possessing red eyes and the other possessing white eyes. Information obtained from the offspring of this cross and a subsequent cross of these offspring provides the basis for a discussion of heredity. Some thoughts about devising "models" to explain data are also considered. Finally, the guide deals with some more subtle points related to the heredity studies. A limited amount of formal genetics terminology sneaks in eventually, but only because the facts and concepts relevant to these specialized terms are "kicked" about so often in the text that it becomes uneconomical, paper-wise, to avoid using them. At any rate, they are few in number and do not change any thoughts, hypotheses or conclusions. So feel free to ignore the likes of "homozygous" and "heterozygous" and stick with Damian's "true blues" and "not so true blues." Either way the concept remains unchanged.

The organism used in these studies is Musca domestica, the common house fly. Normally when one thinks of heredity studies, the first organism which comes to mind is Drosophila melanogaster, the vinegar fly. While Drosophila is an excellent organism for orthodox genetics studies, it has some serious drawbacks for use with eleven and twelve year olds. The house fly, on the other hand, has some distinct advantages. It is a marvelous organism for life cycle studies. Eggs, larvae, pupae and adults are relatively large and easy to manipulate, the entire life cycle requiring only sixteen or seventeen days under room conditions. But most important is the fact that the inheritance of eye color (eyes are one of the fly's most prominent features) in house flies displays a simple dominance pattern which lends itself to much easier genetic analysis than the more complex sex-linked pattern associated with the inheritance of many eye colors (particularly the red-white pattern) in the vinegar fly.

"Like begets like" is a notion much older than the science of genetics. Long before man had any knowledge of genes, chromosomes, DNA, etc., people had successfully mastered selection techniques and, by controlled breeding, produced the majority of domestic plants and animals known today. For example, the Nez Perce Indians of the Northwest, a Stone Age-level people, did not acquire the horse until the early eighteenth century. When they finally "inherited" some of the descendants of the horses brought to the New World by the Spanish Conquistadores, they learned quickly to "improve" the random stock by selective, controlled breeding..... and long before these Indians had any significant contact with "western" man. Many observers credit the Nez Perce with the isolation and development of the magnificent Appaloosa breed so highly prized today. Regardless of whether they bred this type specifically for war horses, there seems little doubt that they maintained large numbers of these peculiar spotted animals in their enormous horse herds.

Intuitively, then, it is quite feasible to study heredity without prior understanding of the major notions associated with the formal science of genetics. Such sophistication is the result of a long human history with selective breeding, not the cause of it. It was with a pre-genetics mindset, then, that we approached the problem of introducing fifth grade youngsters to the notion that Even Flies Remember.

EXPERIENCES WITH CHILDREN

During the spring semester of 1966, forty-four fourth and fifth grade children in the Webster College Experimental School participated in the developmental work which led to the WIMSA publications, On the Fly and The Fly Cycle, and the classroom film, "A Linear Look at the Fly" (thirty minutes). These efforts focused mainly on the husbandry problems associated with the maintenance of house fly colonies over a four week period, plus a few selected "experiments" relevant to "high points" in the fly life cycle. At the conclusion of this work, eight children continued working with the house fly and made the genetic crosses which are the basis of Even Flies Remember. The WIMSA laboratory maintained stock cultures of red-eyed, green-eyed, white-eyed, and brown-bodied flies. Within the limits of combination possibilities, all of the children chose their own crosses and maintained "personal" fly colonies. Table I shows, in array form, the crosses they chose and those which were omitted.

♂

		GREEN	WHITE	BROWN BD.	RED
	GREEN	—	GW	~~G·B~~	GR
♀	WHITE	WG	—	WB	WR
	BROWN BD.	~~B·G~~	BW	—	~~B·R~~
	RED	RG	RW	~~R·B~~	—

Table I

The chart shows all possible crosses including reciprocals. We were surprised to find that the children were quite familiar with the male and female symbols (♂ and ♀)..... from, of all sources, the TV show Ben Casey.

The children were all skilled in manipulating the house fly in culture and made two selected matings and two specific egg inoculations to obtain second generation offspring. The experiments were carried out over a period of five weeks and involved a total "working time" of about twenty-four hours. (Not all of this time was necessarily involved in the heredity work, however, since the children had found other experiments to do while awaiting the outcome of each cross.) Some days the children did not come to the laboratory at all; other days they spent only a few minutes doing maintenance chores; but there were instances when they spent up to two hours doing critical phases of the work.

At the conclusion of the laboratory work (which for several children overlapped the school camp program), we all adjourned to KMOX-TV in St. Louis and wrestled with the problem of finding some "order" in their data. The result is a classroom film, "Mendel Revisited" (forty-five minutes). Then in the fall of 1966, five months later, a second classroom film, "Building Genetic Models" (fifty-five minutes), was made. In this film the youngsters were confronted with data which required modification of the original Mendelian model for simple dominance (see p. 13). At the conclusion of the heredity work last fall, most of the youngsters continued to work in the WIMSA laboratory doing individual problems involving the house fly.

HEREDITY STUDIES IN THE CLASSROOM

Given a choice, most youngsters would opt to "do it yourself" on an individual basis. From the point of view of curriculum innovation, one gets a maximum "exposure" to the experience when each youngster is facing the problems from his own frame of reference. But..... we worked with only eight children and had three or four adults available when necessary. Under standard classroom conditions, however, the one child-one culture concept can pose difficult logistical problems. One teacher in the St. Louis area, Evelyn Pronko of Community School, carried out the entire scheme with just two fly colonies, one white-eyed and one red-eyed. She found that there were many opportunities for the children in her class (fifth grade) to actively participate in the work, despite the fact that twenty-eight children had to share the husbandry of two colonies. Then, too, the number of Petri dish larval cultures is not limited to the number of fly colonies, in that ten or twenty females will lay thousands of eggs during their lifetimes and only a hundred or so eggs are required for larval cultures. Because the red eye and white eye are obvious contrasts, we have elected to write the greater part of the basic experimental section of Even Flies Remember in the context of this cross.

SUPPLEMENTARY INFORMATION

In-depth exploration of almost any phenomenon always seems to raise more questions than are answered. This is particularly true of heredity studies. A successful model which explains data obtained from controlled genetic crosses is a late-comer as scientific models go. The data obtained from pure line crosses of red-eyed and white-eyed house flies so closely parallels that which Gregor Mendel used to build his model for simple dominance inheritance, however, that it seems appropriate to consider his model and one closely related to it in this work.

Then there are the subtle points which are logical extensions of the red-white cross and the Mendelian model. Are all red-eyed flies alike genetically? If not, how can we detect differences? The College School children come to grips with this problem and other similar ones in "Building Genetic Models", and the discussions in this book, where relevant, are patterned after the rationale they followed.

The ideas and experiments discussed in the last section of the guide, VARIATIONS FROM EXPECTED RATIOS, are not critical elements in the basic work. They are intended as background information and/or potential subject matter content depending upon the individual interests of teachers and the grade level of students.

MAKING A GENETIC CROSS

KATHY
KIM O.
DENISE
JUDY

Figure 2

SETTING UP THE CULTURES

If one examines wild house flies closely, they all look distressingly alike. Except for occasional variations in size and the ever-present differences between males and females, it is extremely difficult to find clear-cut differences between flies. Each fly looks as if it was "stamped" out by a master mold, with hardly a blemish to distinguish it from other members of the species. Differences do occur, however. Patient breeding of large numbers of flies in laboratories has turned up varieties of house flies which differ from the normal wild type.

Wild type house flies found in nature have gray-black bodies and large red eyes. In artificial light the eyes often appear to be brownish in color; but if you look at them in the full-spectrum visible light of the sun, they are a glistening bright red. Eye colors other than red are very, very rare in wild populations, but white-eyed varieties have been found and cultured in the laboratory. White eye is really a misnomer, the true color being a silvery gray. But white or gray, a fly possessing this unusual eye type is strikingly different from the normal red-eyed fly.

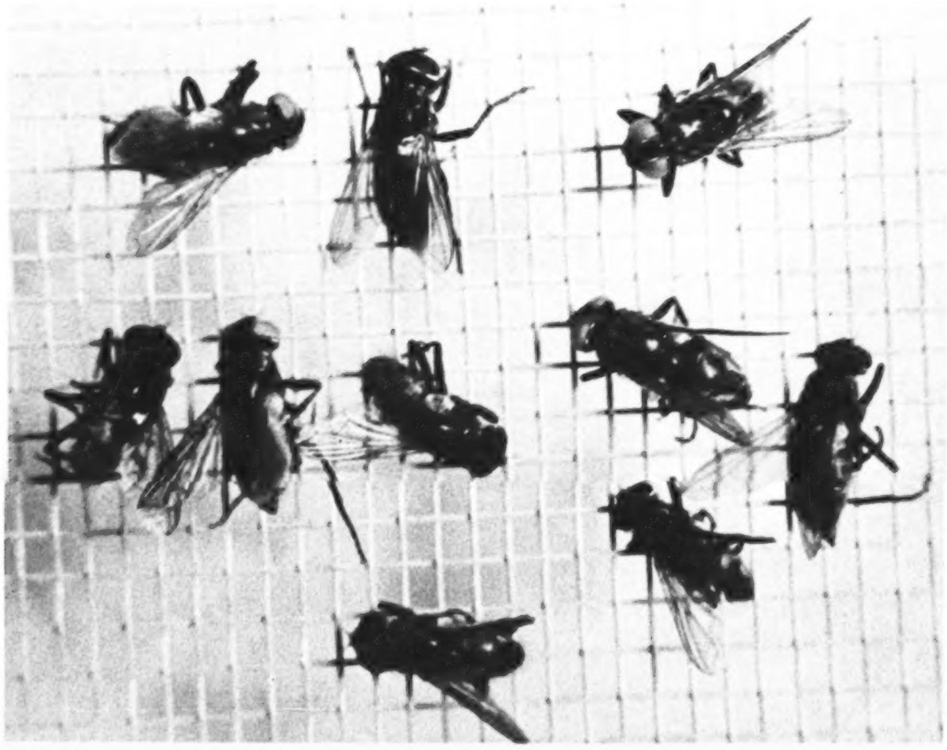

Figure 3

Even in black and white photographs the eye colors are easily identifiable.

For heredity studies it is probably best to obtain both red-eyed and white-eyed flies from a commercial supply house. While it is not difficult to obtain a "starter" culture of red-eyed flies from the great out of doors "reservoir", wild fly populations frequently tend to have high ratios of males to females. Strangely enough, this high male ratio seems to be hereditary in that it persists through many generations of laboratory culture. Actually a wild strain is not any more difficult to culture, but it requires that one make a special effort to "balance" the sex ratio by selection each time a new colony of adults is started. In addition, the biological activities of freshly isolated wild flies show a wider range of time variability than that displayed by "tame" cultures.

Once the two cultures of red-eyed and white-eyed flies are established and have been observed for a while, one becomes aware of differences other than eye color. White-eyed flies seem more sluggish and fly very little. Sudden changes in light intensity or observer motions do not seem to agitate the whites, while the red-eyes fly about frantically under the same conditions. Perhaps the most striking difference one observes occurs when a hand is put into the cage for feeding purposes, etc. The reds really get shaken up and fly all over, but the whites are unperturbed, often lighting on the hand and staying there. Unless one is careful, they will help themselves to a "free ride" outside the cage when the hand is withdrawn. "Escapes" by whites are not a problem, however, because they can be recaptured easily and returned to the cage. THE WHITE-EYED FLIES ARE NEARLY BLIND!

MAKING THE FIRST CROSS

Once the red and white strains have been cultured through one life cycle (pupa to pupa) and pure line pupae have been obtained, preparations can be initiated for cross-breeding. The most important thing about making any specific fly cross is to be certain you are making the cross you think you are making; that is, if white females are to be crossed with red males, an absolute "fail-safe" system of sex separation and identification must be made. A "stray" white male or red female in the colony can wreak havoc on "expected" ratios of whites to reds in later generations. (See VARIATIONS FROM EXPECTED RATIOS, p. 21.)

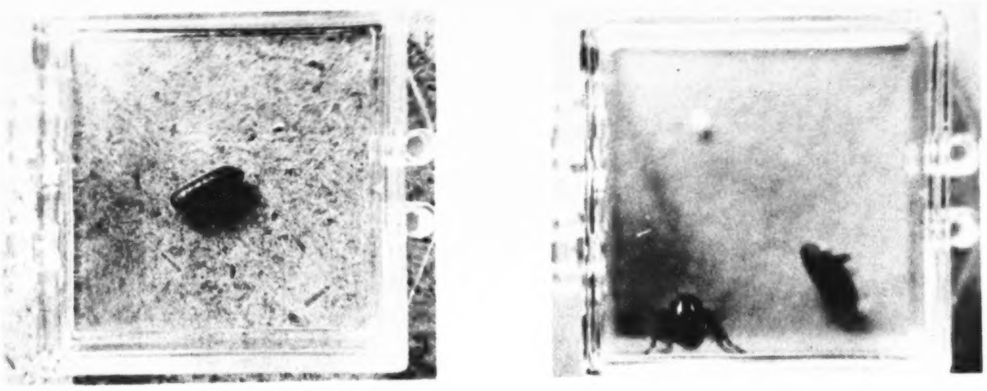

Figure 4

If pupae are placed in individual pill boxes they will produce single flies in isolation from other flies. This technique insures sex separation and offers "fail-safe" guarantees against miscegenation. On the average, flies will live at least twenty-four hours in the pill box without food or water.

The pill box method of separation has other advantages in terms of classroom activities. Many children can examine the flies in the boxes, and the numbers of males and females can be determined by all interested parties..... before any "commitment" is made to the final "mix".

Female flies are easily distinguished from males once a colony has been going for a few days. The females, gorged with eggs, have enlarged abdomens which give a clue that is almost foolproof..... but after the fact. Identifying the sexes when the flies are newly emerged from the pupal cases is another problem. There are abdominal differences, but they are sometimes too subtle in young flies. The most obvious difference between males and females is in the spacing of the eyes.

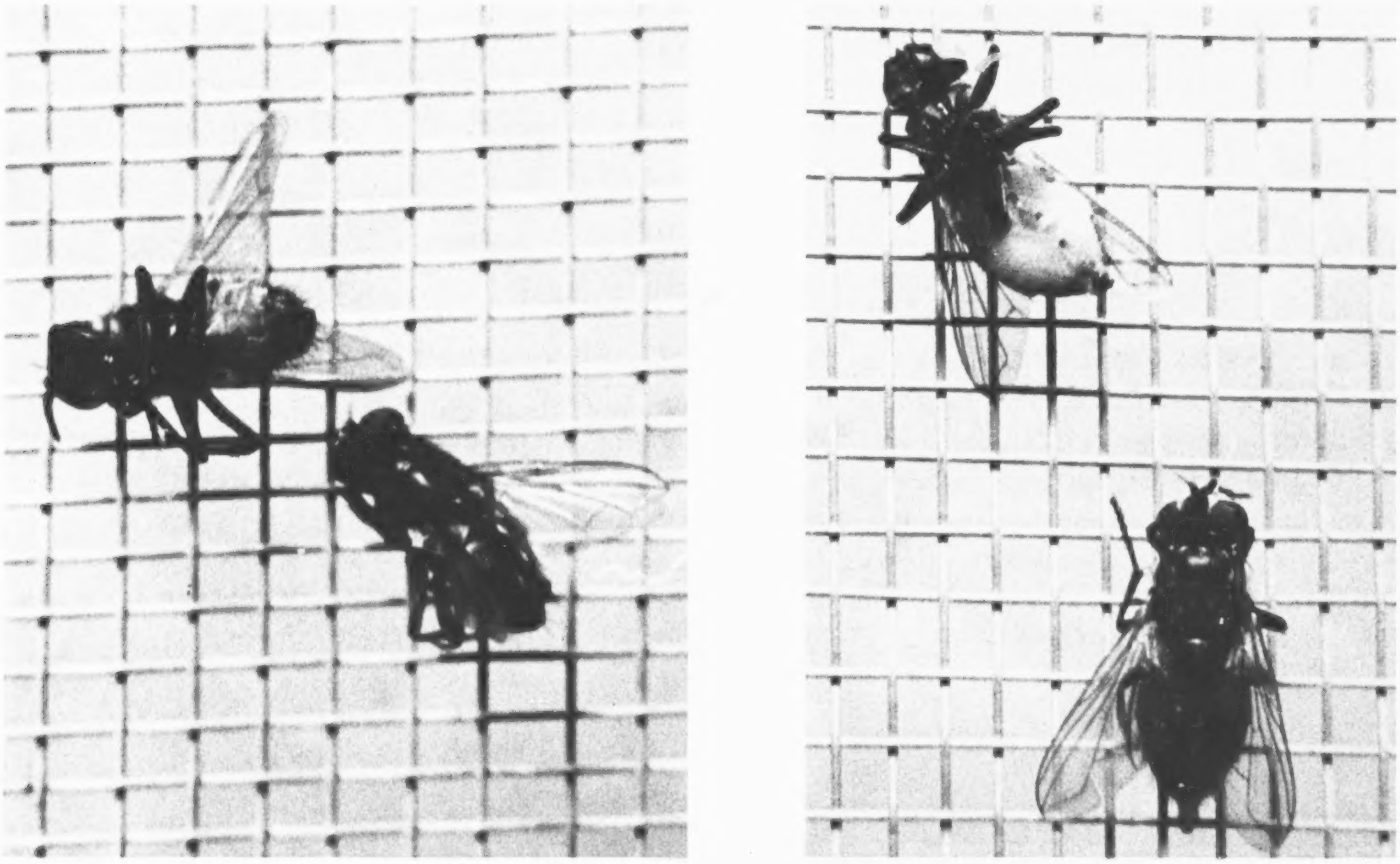

Figure 5

The flies on the left are males; those on the right are females. The eyes of the male nearly touch one another at the top of the head to form a "V", and the tip of the abdomen is marked by a pronounced black patch. In contrast, the eyes of the female are widely spaced at the top of the head, and the abdomen is more pointed with just a single pore at the tip. Correlating both abdominal and eye traits helps to insure complete sex separation.

There is no magic number of flies for a jar colony in heredity studies, but we have found that a mix of ten red males and ten white females produces good results. In our experimental classes, the youngsters insisted on making the reciprocal cross; that is,ten white males to ten red females. They were greatly concerned as to which sex played the greater role in heredity.

WHAT WILL THE CHILDREN FROM THE RED-WHITE CROSS BE LIKE?

One of the nice things about heredity from a pedagogical point of view is that the questions one might ask regarding breeding are reasonably obvious and autocatalytic for youngsters who have mastered the husbandry techniques of fly culture. (See On the Fly.) In the case of the original red-white cross, for example, the question, "Do you think the red-eyed flies and white-eyed flies will mate and produce offspring? ", is logical and will probably be raised by one or more of the children, if not by the teacher. Given this question as a starting point, the twin problems of designing the mechanics of sex separation and making the cross are quite solvable within the bounds of the youngsters' range of experiences.

It is interesting to speculate about the eye color of the offspring resulting from the crossing of red-eyed and white-eyed house flies..... before they emerge from the pupae. The children we worked with proposed just about every possible hypothesis and a few more besides:

> They will be pink-eyed, halfway between red and white.
> They will be like their mothers.
> They will be like their fathers.
> The males will be like their fathers, and the females will be like their mothers.
> The females will be like their fathers, and the males will be like their mothers.
> The males and females will be different than their parents.
> They will be red.
> They will be white.
> Maybe they will have one red eye and one white eye!

Every rumor the Experimental School children had ever heard about heredity became the basis for a "theory". Fortunately the answer to the question was inside the pupal case and would be revealed automatically in the developing fly's own time. Pedagogically we found this state of affairs to be most comfortable in that we did not have to take sides, leaving each youngster's opinion with as much basis in fact as anyone else's. Even though the children knew that it took seven days for the pupae to produce adult flies, their eagerness to see the outcome prompted them to make daily visits to the laboratory to check for newly-emerged flies.

RESULTS FROM THE RED-WHITE CROSS

No matter how many times the cross between pure line reds and pure line whites is made, the results are always the same -- all red eye..... provided, of course, the whites used in the cross are all the same sex. The children in our experimental group were quite distressed at this state of affairs, but the most distressed of all were the children who had crossed white eye and green eye. They had hypothesized all kinds of intermediates, but all they saw was RED.

Before you see the color of the eyes of the first offspring, however, you must first harvest and box all the pupae in preparation for another cross..... that is, our youngsters insisted on doing this. Following their usual strong maternal and paternal instincts, they proceeded to carefully place each pupa into a pill box to guarantee "isolation" of males and females. There is a ridiculous anecdote connected with this procedure. It is worth relating here because it reflects upon the mindsets and pedagogical attitudes of adults. Miss Dignam, Mrs. Eckelkamp and myself KNEW that the offspring of the pure line crosses would all be red-eyed. For us there was no reason to box the pupae the second time around; we would end up mixing the adult flies at random anyway. Since the youngsters were working individually, boxing several hundred pupae meant at least an hour of work for each of them. All of our time-saving, hurry-up-and-get-on-with-it instincts (cult of efficiency) were strained to the breaking point. In the end, however, our feeling for the naive intellectual honesty of the children won out over our own "corner-cutting" mindsets. Meanwhile we marked time impatiently, while the children happily established one-to-one correspondence between pill boxes and pupae.

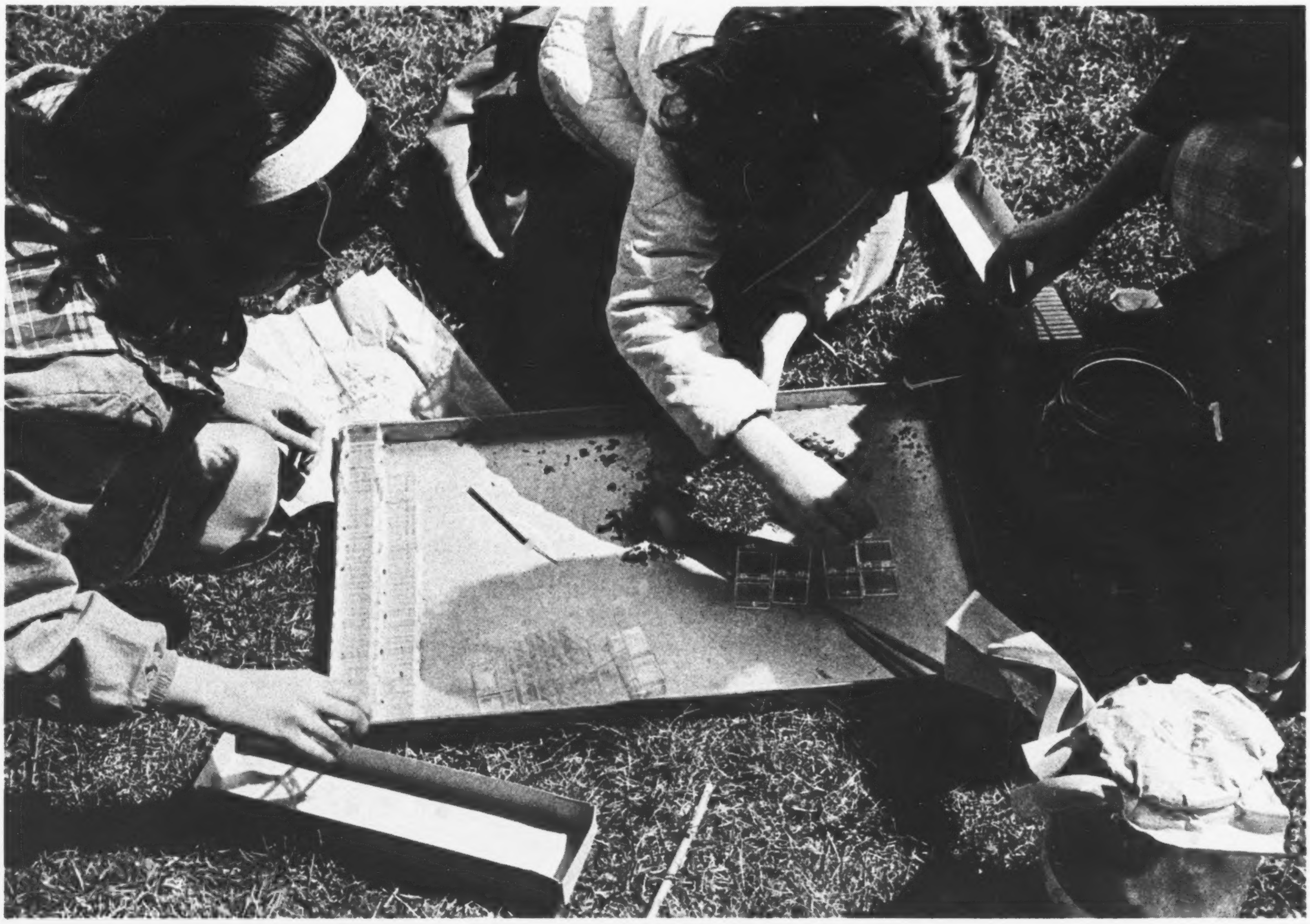

Figure 6

While the adults "chewed" their nails and watched the clock, the children, oblivious to all, happily established one-to-one correspondence between pill boxes and pupae from pure line crosses.

Some months later after watching the first "showing" of the classroom film, "Building Genetic Models", we felt that our guilt feelings about loss of time were partially assuaged. The time "wasted" for honest inquiry seemed to have a "long loop" pay-off in terms of the youngsters' attitudes in coming to grips with problem-solving situations.

THE SECOND GENERATION

If the first generation (all red) was disappointing and frustrating to the children, the second generation more than made up for it. White eyes appeared again, even though their number was small compared to red eye. The most important thing is that Even Flies Remember.

The cross of red-eyed flies that are descended from pure line whites and reds has been made and followed through many times in the WIMSA laboratory. The results nearly always turn out to be much alike, and inheritance of eye color appears to be independent of the fly's sex. Table II summarizes the results of four such crosses made in our laboratory during the late winter and early spring of 1967.

PUPAE	WHITE	RED	UNHATCHED
106	25	77	4
no data	16	49	no data
"	17	45	"
"	21	69	"
	79	240	

Table II

Some variation occurs from culture to culture, but the net result of 240 reds and 79 whites gives a ratio of approximately 3.03 · 1.

. . . .

It seems to me that at this stage in the scheme we come to a distinct "breaking point". White eye "disappears" on occasion, but only temporarily. Upon crossing the offspring of red-eyed and white-eyed parents, white-eyed flies reappear in the second generation. Those unknown humans whose careful selection and breeding of plants and animals helped transform man from a scavenger-hunter existence to a pastoral one must have understood intuitively what Mendel later termed dominance and recessiveness. If they counted carefully, classified and kept neat records, they left no evidence to guide us in following their rationales. Certainly the Nez Perce did not keep such records. They lacked a written language. It remained for an Austrian monk late in the nineteenth century to cope with numerical data similar to that in Table II and to build a model which explained the disappearance and subsequent reappearance of recessive traits.

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BUILDING GENETIC MODELS

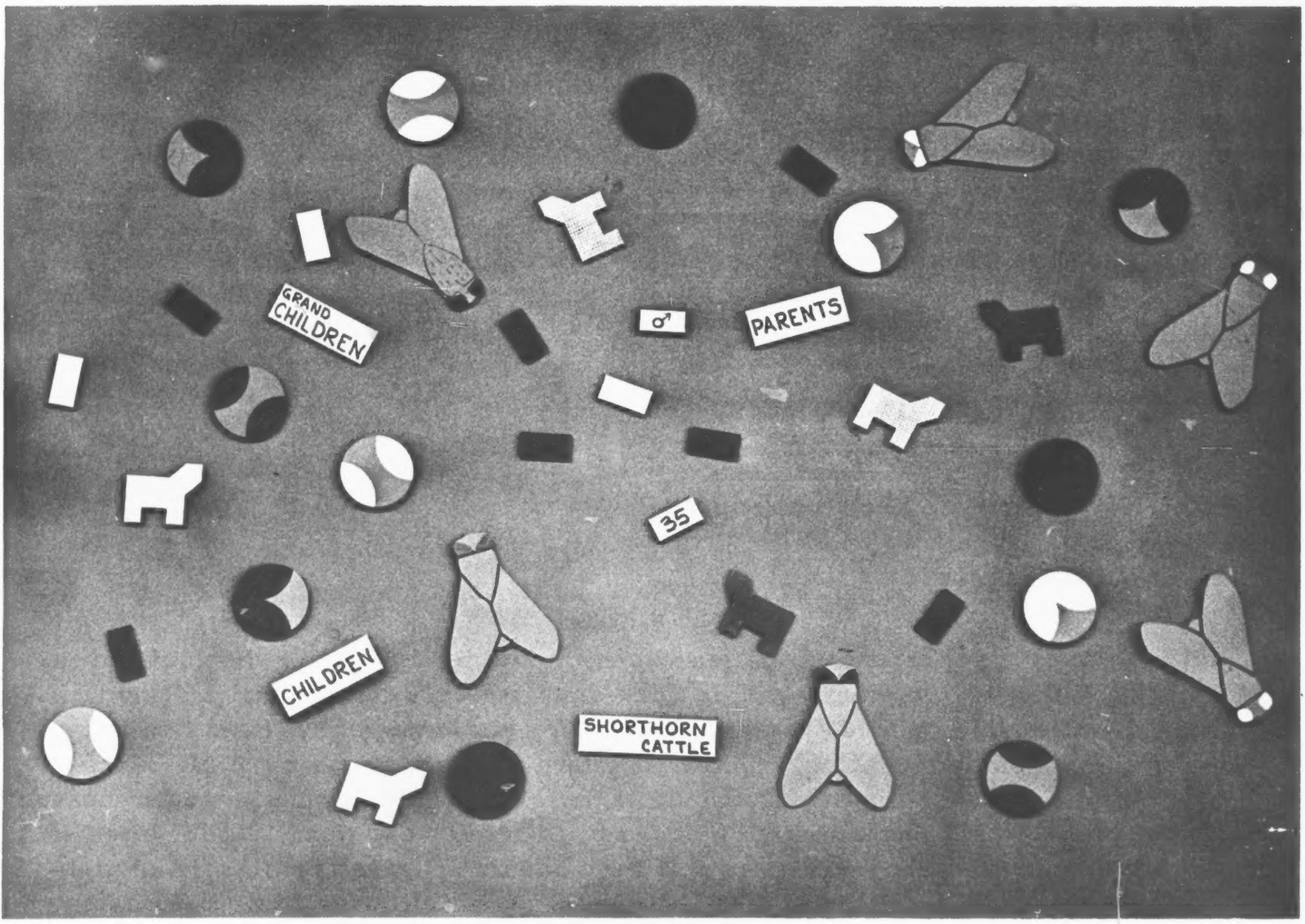
GRAND CHILDREN
♂
PARENTS
35
CHILDREN
SHORTHORN CATTLE

Figure 7

BUILDING A MENDELIAN MODEL

Gregor Mendel succeeded in building a "lasting" model to explain heredity data where all others before him had failed. Although much of Mendel's formative thinking during the early days of his work is shrouded in obscurity, the end result of his efforts has stood the test of time to become the bedrock of the modern science of genetics. Modified, qualified and supplemented over the last half century, Mendel's discovery of simple whole numbers in genetic data and his hypothesis of "twoness" to explain heredity in higher plants and animals, nonetheless, goes unchallenged even in these modern times.

When one has data such as 77 reds and 25 whites (No. 1, Table II, p. 11) in the second generation (grandchildren) from an original cross of pure line red-eyed and white-eyed flies, how can such data be used to build a model which explains it? Clearly the assumption that each parent contributes to the offspring is obligatory. Even the primitive Nez Perce must have realized this fact. Equality of contribution by the male and female, however, is a concept no older than the late eighteenth century. Given equality of contribution as a premise and the data from two generations of house flies as the basis, one might attempt to reconstruct the reasoning behind Mendel's model for simple dominance.

THE FIRST TRY

A house fly strain which produces offspring having only one eye color generation after generation is considered to be "pure line" for that trait. When pure line red-eyed flies are crossed with pure line white-eyed flies, the resulting offspring all have red eyes (p. 15). When these red-eyed offspring are crossed, however, some white-eyed flies appear in the next generation. In considering such a series of crosses, it is convenient to use a system of notation to delineate clearly one cross from another. Thus, the original cross (red x white) is referred to as the parental (P_1), the first generation (all red) as the first filial (F_1), the second generation (reds and whites) as the F_2..... F_3..... and so on.

Mendel must have spent many years wondering why some of the traits possessed by the pure line pea plants which he had crossed "disappeared" in the F_1 generation only to reappear again in the F_2, while other traits continued to appear in generation after generation. He coined the term "recessive" for those traits which tended to disappear in the F_1 and "dominant" for those traits which tended to persist generation after generation. If Mendel had worked with house flies instead of garden peas, he would have assumed red to be dominant over white for eye color.

Perhaps the simplest model Mendel would have proposed for eye color inheritance in house flies would have been to assume that a pure line red-eyed fly carries a single "factor" for red eye and a pure line white-eyed fly carries a single "factor" for white eye.

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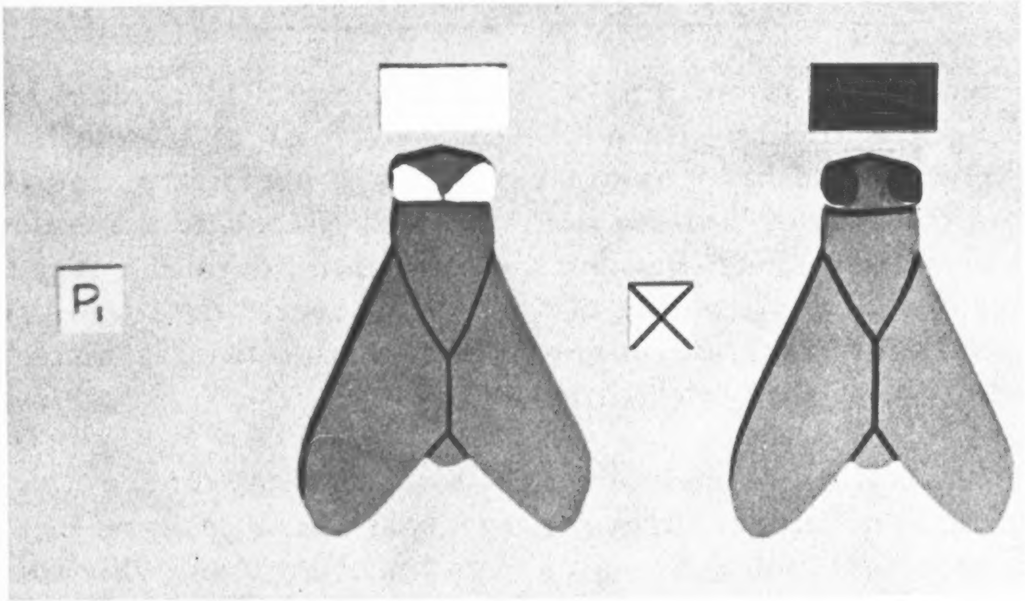


Figure 8

The simplest model assumes that each fly possesses a single factor for each trait (indicated by the rectangular symbols). In the classroom film, "Mendel Revisited", the phrase "memory card" was coined for these factors. Both the fly symbols and the memory cards have small ceramic magnets glued to their backs to allow for easy attachment to iron-backed blackboards.

Difficulties in the one-memory card system show up immediately when one tries to assign memory cards to the F_1. If the assumption is made that each F_1 fly gets only one memory card (it has to be red), then a "source" of white memory cards needed for the F_2 is no longer available. In the classroom film, "Mendel Revisited", the children from the Experimental School propose an "additive" model, suggesting that the F_1 offspring from the pure line cross (P_1) get a memory card from each parent and, in turn, possess two memory cards (one card for each eye color). Meanwhile, someone suggests that red is "stronger" than white and "overtakes" it. Some youngsters then went on to suggest a three card system to explain the F_2. One could, I suppose, build a very complex and perhaps "valid" model based upon the additive system. But one of the youngsters discovered a fatal flaw in the logic of this argument. It is all well and good to say that the number of memory cards increases from generation to generation, but "they (the original parents) had to come from some kind of flies." (The inference here is that at some past time the P_1 would have to be considered F_1, F_2..... and why should these flies have only one memory card per fly for eye color?)

If Gregor Mendel ever actively considered a one-memory card system, it is another facet of his genius that he discarded it in favor of raising the ante one and adopting instead a two-card, non-additive, determinate system. In building the model based upon two memory cards, Mendel assumed two factors (later someone called them the "genes") for each trait. Thus in the Mendelian model each house fly would have two memory cards for eye color, the original pure line parents (P_1) possessing two cards for red eye or two cards for white eye; and the F_1 flies each possessing a memory card for white eye and another for red eye, their parents each contributing one card according to their type.

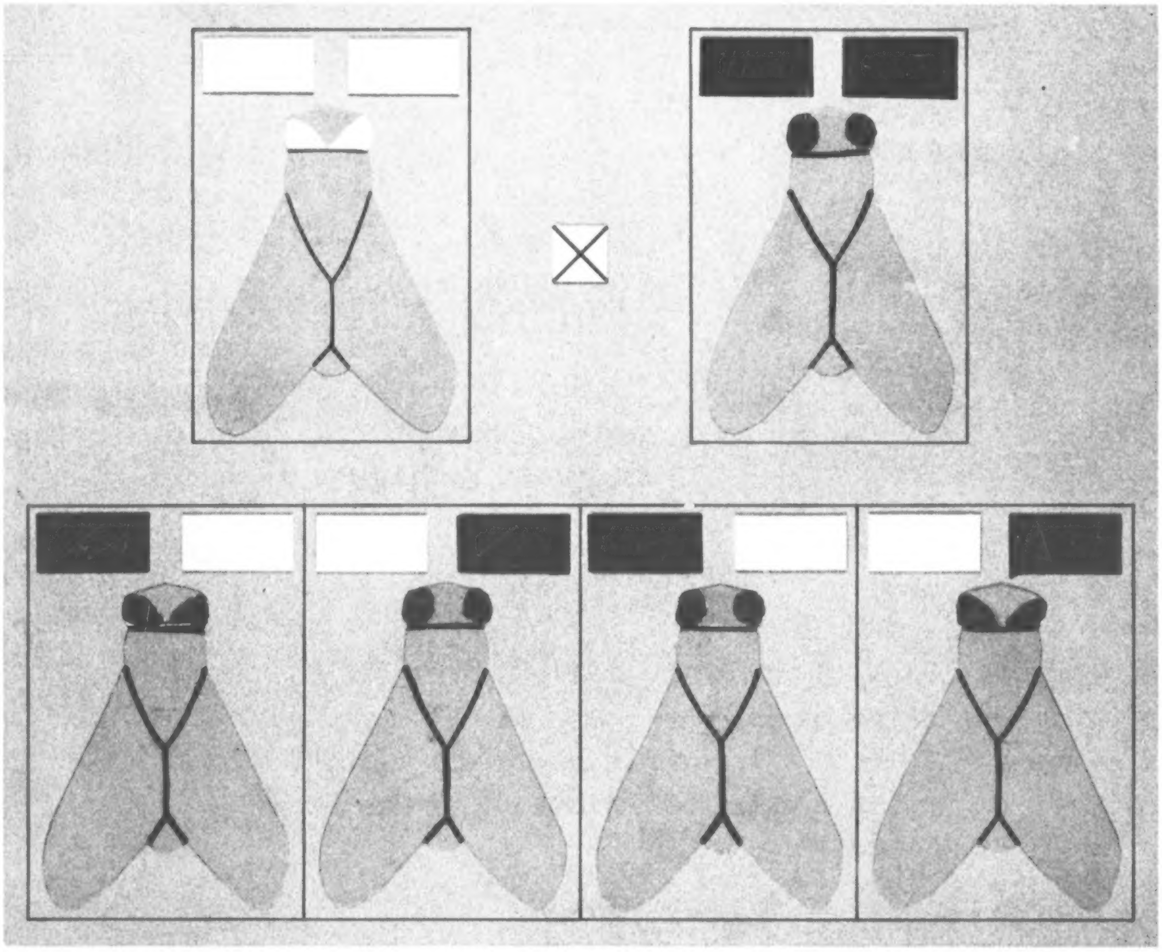
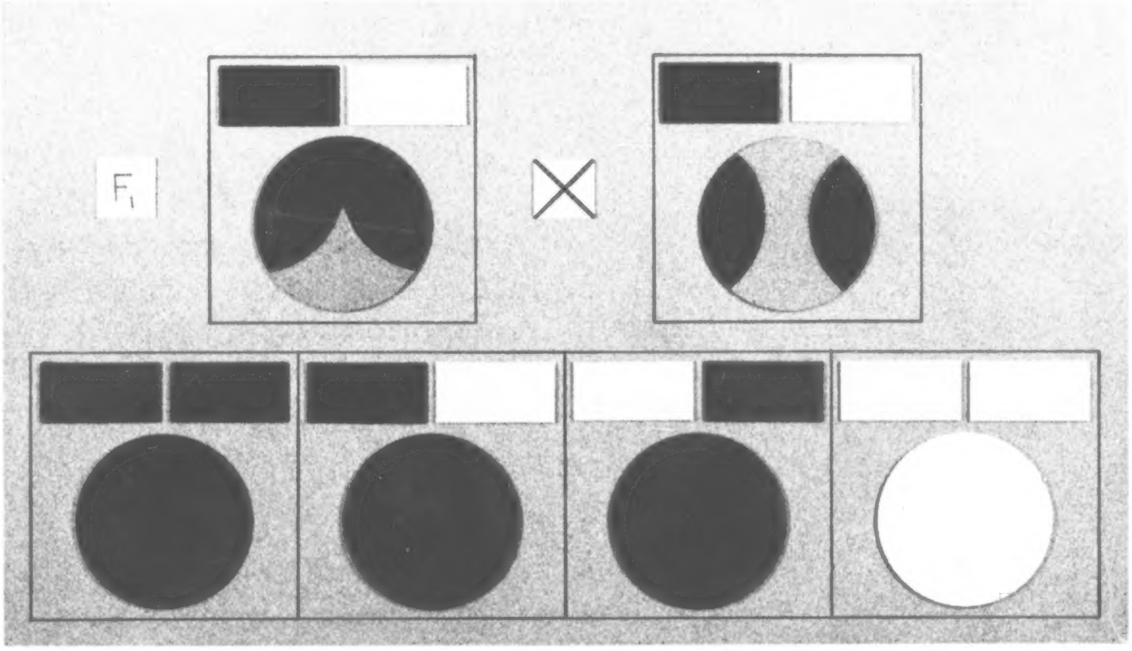


Figure 9

The two card system provides for "equality of contribution" from both male and female parents and allows the gene for white eye to be "carried" by the F_1 red-eyed flies.

When the F_1 reds are crossed, the Mendelian model predicts that it is possible to get white-eyed flies again in the F_2. This prediction is consistent with the actual data obtained from analysis of an F_2 generation (77 reds and 25 whites).

Figure 10



Since each F_1 parent possesses a red and a white memory card, random distribution to the offspring will eventually yield all four combinations shown in the diagram of the F_2. The fly "eyes" in the F_1 represent sex symbols; the colored discs in the F_2 represent only eye color as a class.

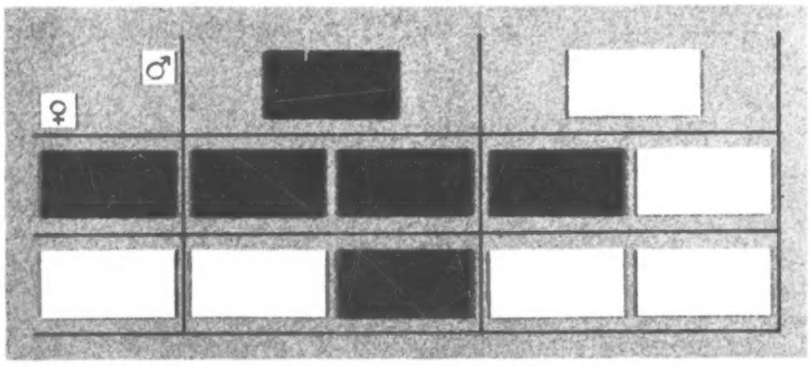
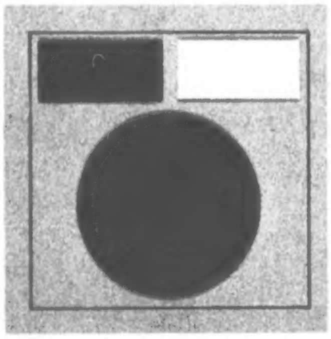


Figure 11

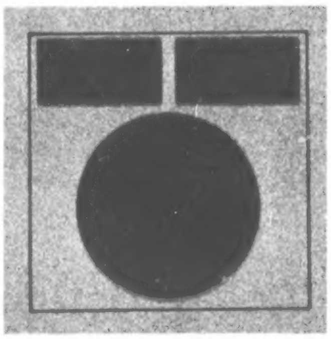
The possible F_2 combinations resulting from the F_1 cross shown in Figure10 can be portrayed more graphically by means of the array diagram in Figure 11.

All possible combinations of memory cards from the F_1 cross are shown in Figure 11 . The ratio of red-eyed flies to white-eyed flies is 3 · 1, one of the reds being "pure", two reds carrying a gene for white, and the lone white being double recessive.

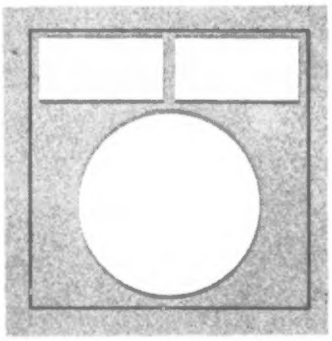
Since the Mendelian model for simple dominance shows three "different" types of flies (genetically) in the F_2, the introduction of a few specific terms at this point will help to short-circuit tedious description in the remainder of the text.



A fly may be red-eyed but carry a gene for white eye. The red disc indicates the phenotype -- or the appearance of the fly for this trait. The two cards indicate the innate heredity potential of the fly for eye color, or genotype. A fly possessing different genes for a trait is heterozygous for that trait.



Some flies showing the red eye phenotype have a double red genotype. Such a fly is said to be homozygous for the trait.



A white-eyed fly shows the phenotype white. Because the gene for white is recessive to that for red, white-eyed flies must have a pair of genes for white and are always homozygous for the trait.

Figure 12

INCOMPLETE DOMINANCE

Inheritance of traits as described by Mendel's dominant-recessive pattern is widespread in the animal and plant kingdoms. Hundreds of traits in corn, mice, flies, beetles, humans, etc. show inheritance patterns which can be explained by postulating that one gene is dominant and another is recessive, as in the red-white eye color pattern of house flies. There are instances, however, when a kind of "blending" of characters seems to occur. Instead, for example, of red dominating white in the F_1 when pure line reds and whites are crossed, the offspring show an intermediate color pattern. Such is the case in pure line shorthorn cattle.

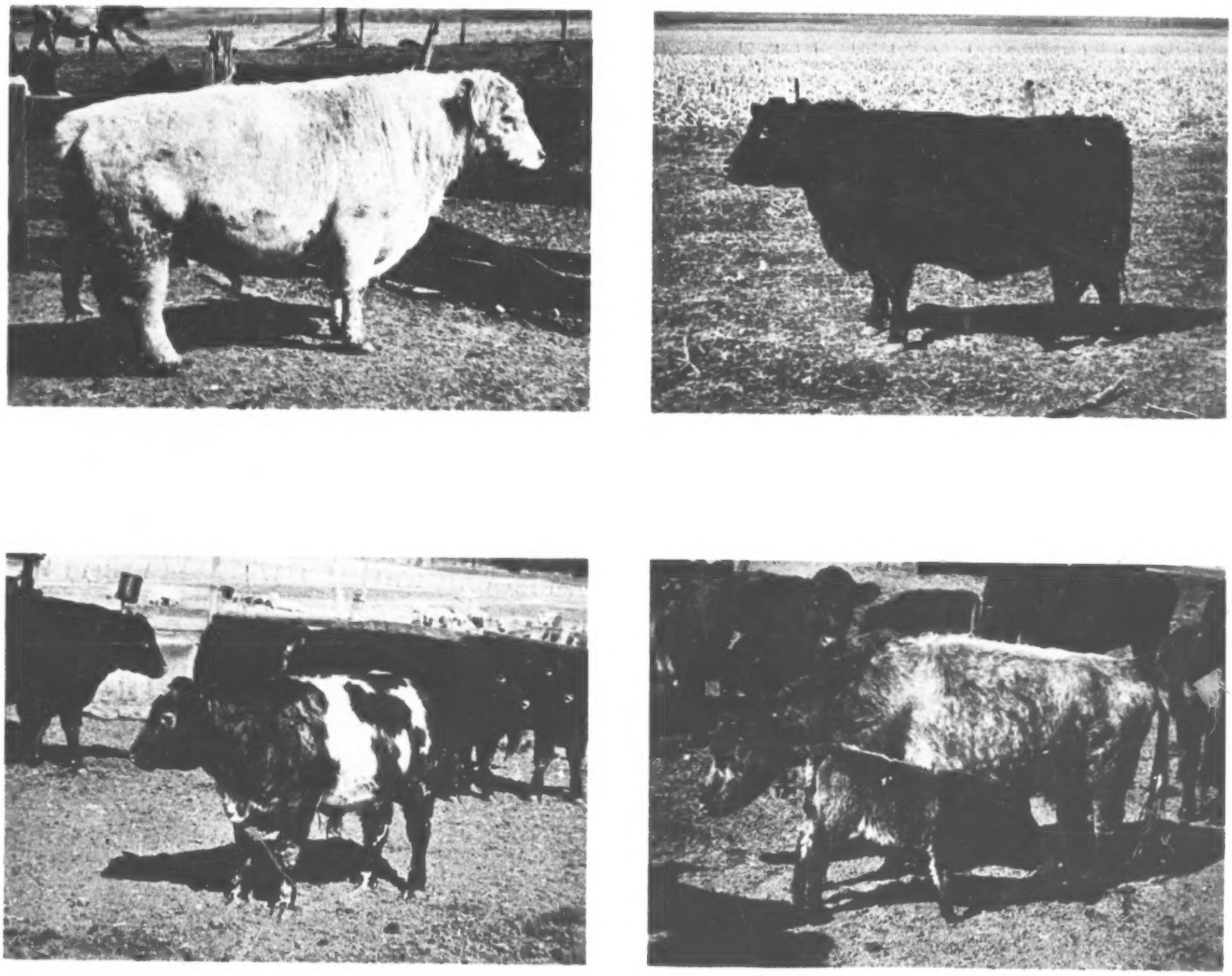


Figure 13

The bull in the top left hand picture is a pure line white, while the cow in the top right hand picture is a pure line red (brownish-red). The bottom pictures show two types of intermediate roans which could result from a cross of a bull and a cow similar to those pictured.

In the classroom film, "Building Genetic Models", we confronted the children with the problem of intermediate inheritance. Since we were unable to bring the cattle into the TV studio, we did the next best thing which was to fashion red, white, and roan symbols resembling "cows" (Figure 14).

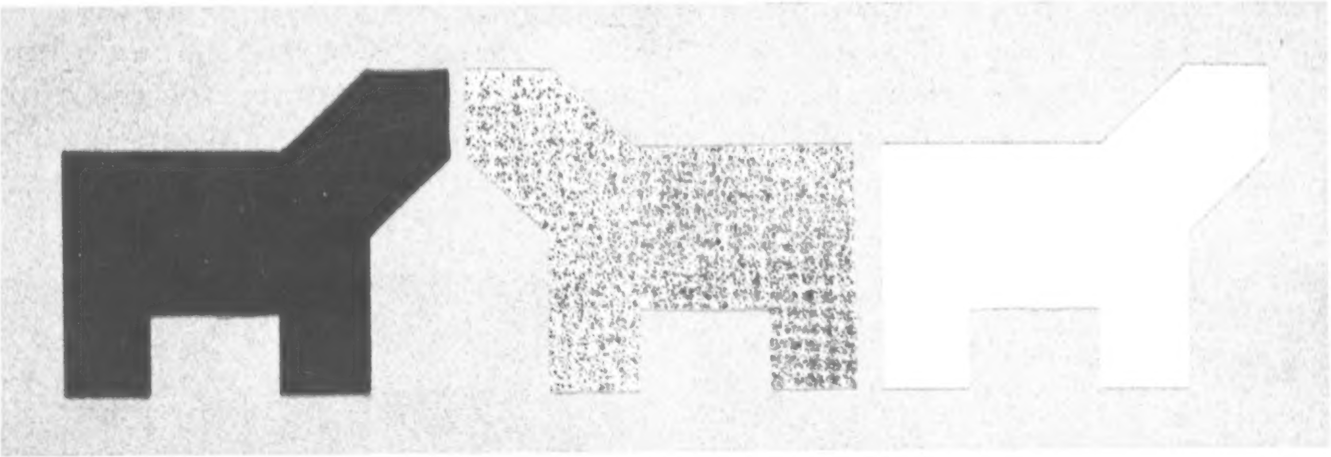


Figure 14

Suppose one were to cross a white bull from a herd of cattle which was all white and had been white for generation after generation (pure line concept) with a red cow whose ancestral history was similar. What do you think the offspring would be like? Well! We got the full range of responses, both individually and collectively -- roans, whites, reds and in all possible combinations. It turns out, however, that when pure line red and white cattle are crossed, one gets roan each time (Figure 15).

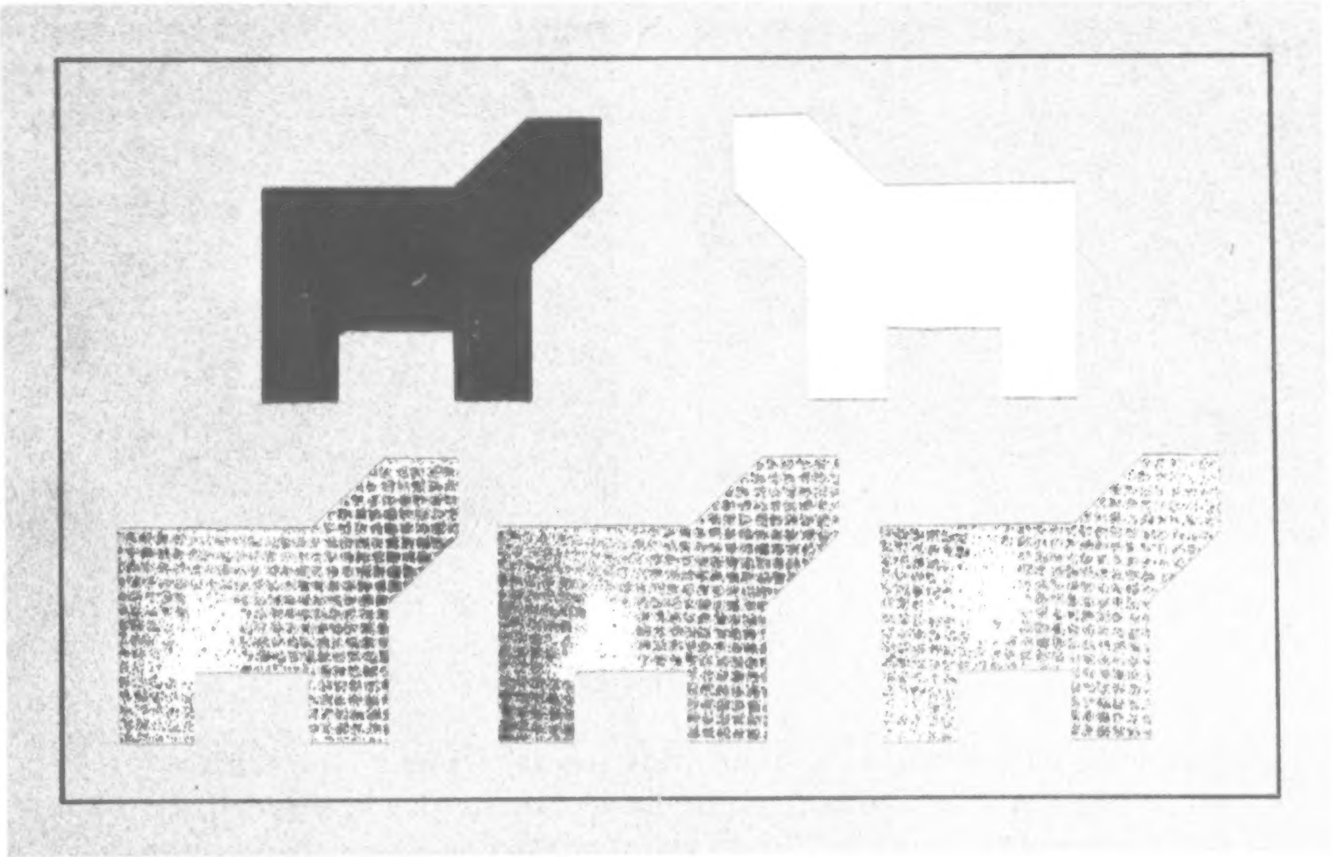


Figure 15

If a cross of pure line reds and pure line whites gives the intermediate, roan, what kinds of "memory cards" (based upon the two-card system) would you assign to each of the parents? The youngsters agreed unanimously that one parent should have two red cards and the other two white cards..... "if it's like flies." Furthermore, most of the children opted for one white and one red card for the roan offspring (F_1), though at first one or two of them were not certain (Figure 16).

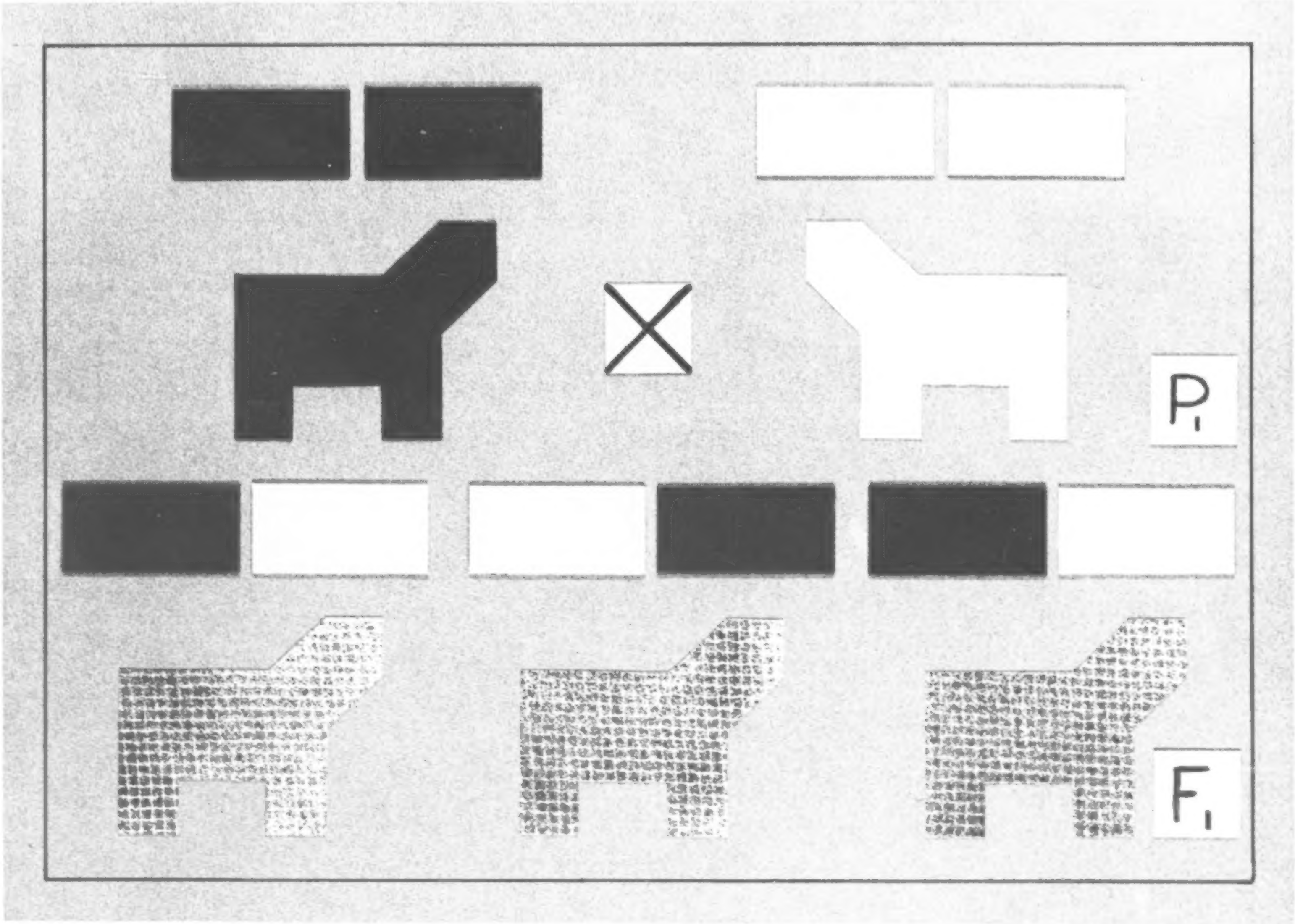


Figure 16

Suppose, now, one crosses two roan cattle. What will their children be like? Our youngsters had many opinions..... and they expressed them quite freely. Several made shrewd guesses that they would be red, white, and roan, but mostly roan. Then one youngster working conceptually from the model which had been built for flies formulated beautifully the 1 · 2 · 1 ratio..... one red, two roans and one white. Her language in the classroom film, "Building Genetic Models", went something like this, "I think they'll be mostly roan -- 2/4ths roan, 1/4th red and 1/4th white..... "

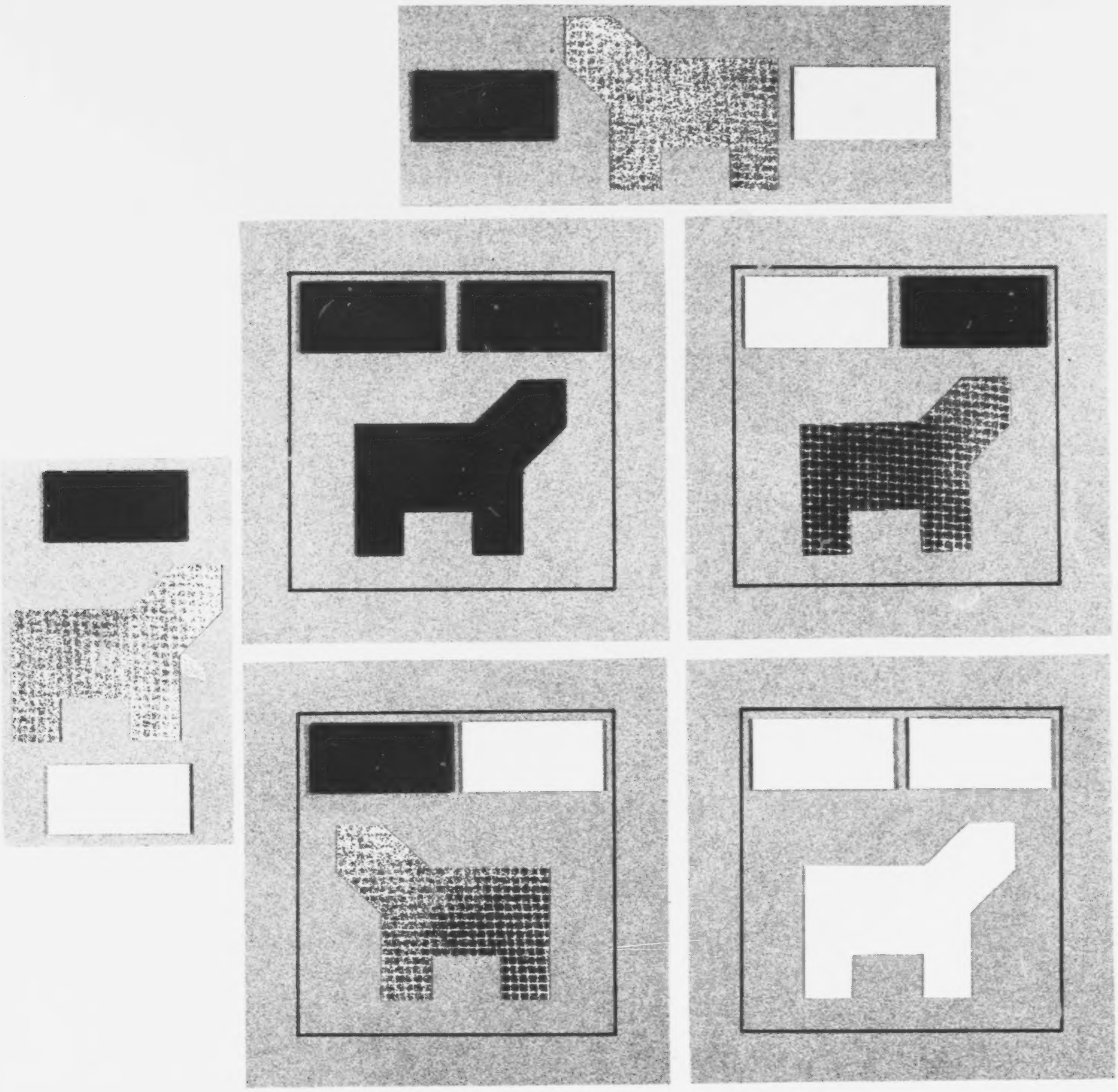


Figure 17

The roan parents each possess a red and a white gene for coat color. Each parent contributes either its red or white gene to the calf. The "square" diagram shows "ideal" results, in that all four possible combinations are shown in the children.

In the intermediate type inheritance pattern, Mendel's model for simple dominance has to be modified slightly, but the roots of his ideas are still the basis of the explanation. Twoness, the notion that the inheritance of a given trait is determined by a pair of genes, remains unchanged. The most important deviation from the Mendelian model is that the genes for red color and white color are considered to have equal "strength", resulting in the appearance of a third phenotype, the intermediate color, roan.

3

VARIATIONS FROM EXPECTED RATIOS

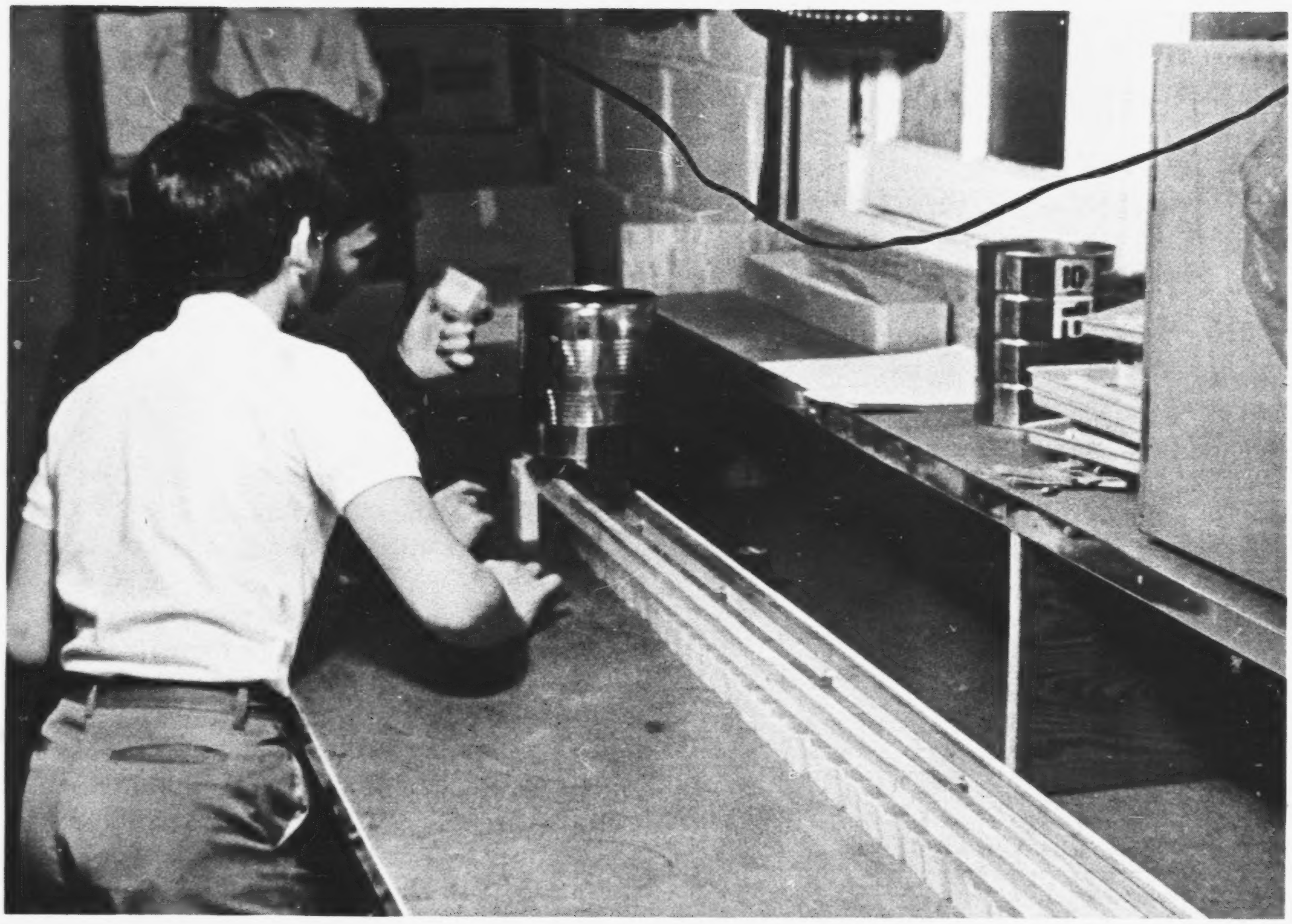


Figure 18

TOM'S RESULTS

In the classroom film, "Mendel Revisited", the red-white cross made by Tom was selected as the basis for building a model. Tom had classified and counted the flies in his F_2 generation and came up with 132 reds and 35 whites. A quick calculation ($\frac{132}{35}$ = 3.79 · 1) shows a ratio much closer to 4 · 1 than to the normal 3 · 1 expected when a simple dominance pattern is suspected. Since Tom counted a total of 167 flies, he should have gotten approximately 125 reds and 42 whites. Given the Mendelian model developed on p. 15 , why does Tom's data vary so greatly from that predicted by the model? Since chance plays a role in the distribution of genes, it cannot be ruled out as an explanation (Figure 19).

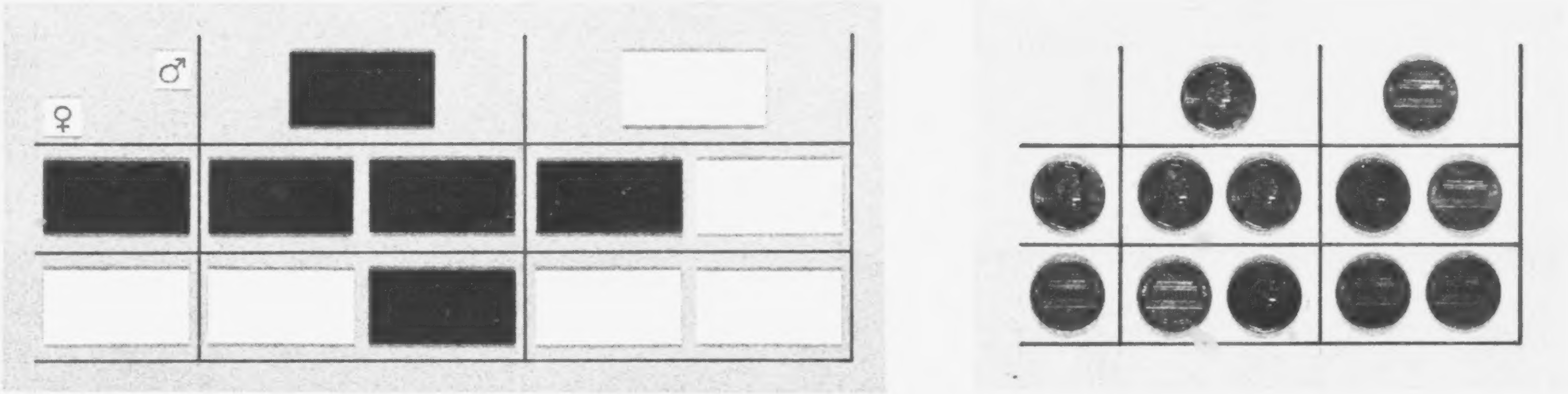


Figure 19

The probability that each fly parent will contribute the "proper" gene to produce the four possible combinations shown in the left hand picture is about the same as one flipping pennies and reproducing the results shown in the right hand picture. In the heredity model each parent contributes either a gene for white eye or a gene for red eye. In coin flipping, the penny turns up either a heads or tails..... provided, of course, it does not stand on end.

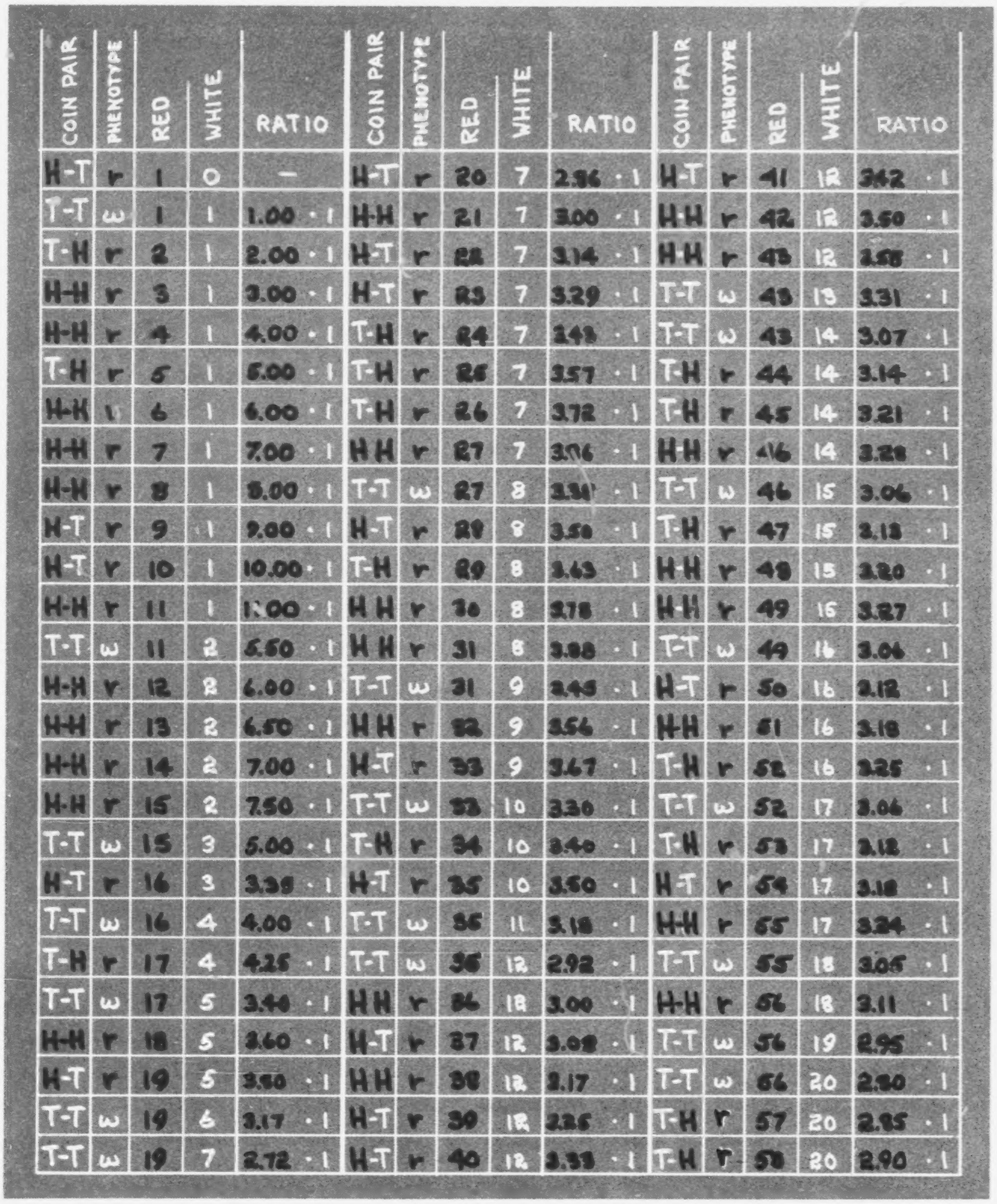
1	2	3	4
H-T	H-H	H-H	T-T
T-T	T-H	H-T	H-H
T-H	H-H	H-T	H-H
H-H	H-H	H-H	H-H

Table III

The results from flipping pairs of pennies can be determined experimentally. While writing this section we decided to flip pairs of pennies to compare the "real" data with that in the model in Figure 19 . The combinations obtained in four different experiments are shown in Table III . In only one instance, the first experiment, do the ideal results appear. In the other three cases considerable variation from the model occurs. The ideal distribution of combinations does not show up each time and, indeed, may not show up at all in a series of coin flipping experiments.

The analogy between flipping pairs of coins and the contribution of genes by the fly parents can be stretched a little further. One could assume, for example, that "H" symbolizes the gene for red eye and "T" the gene for white eye. Based upon the data in Table III , this would give the following phenotypes and genotypes: red, 14 (6RW and 8RR) and white,2 (both WW). The ratio of reds to whites $(\frac{14}{2})$ is 7 · 1, quite a discrepancy from the expected 3 · 1.

We decided to continue flipping pairs of pennies to see how the ratio would change as we accumulated a larger and larger number of "individuals" in the sample. The data in Table IV shows the results from 78 cases (including the original 16 trials).



COIN PAIR	PHENOTYPE	RED	WHITE	RATIO	COIN PAIR	PHENOTYPE	RED	WHITE	RATIO	COIN PAIR	PHENOTYPE	RED	WHITE	RATIO
H-T	r	1	0	—	H-T	r	20	7	2.86 · 1	H-T	r	41	12	3.42 · 1
T-T	ω	1	1	1.00 · 1	H-H	r	21	7	3.00 · 1	H-H	r	42	12	3.50 · 1
T-H	r	2	1	2.00 · 1	H-T	r	22	7	3.14 · 1	H-H	r	43	12	3.58 · 1
H-H	r	3	1	3.00 · 1	H-T	r	23	7	3.29 · 1	T-T	ω	43	13	3.31 · 1
H-H	r	4	1	4.00 · 1	T-H	r	24	7	3.43 · 1	T-T	ω	43	14	3.07 · 1
T-H	r	5	1	5.00 · 1	T-H	r	25	7	3.57 · 1	T-H	r	44	14	3.14 · 1
H-H	r	6	1	6.00 · 1	T-H	r	26	7	3.72 · 1	T-H	r	45	14	3.21 · 1
H-H	r	7	1	7.00 · 1	H H	r	27	7	3.86 · 1	H-H	r	46	14	3.28 · 1
H-H	r	8	1	8.00 · 1	T-T	ω	27	8	3.38 · 1	T-T	ω	46	15	3.06 · 1
H-T	r	9	1	9.00 · 1	H-T	r	28	8	3.50 · 1	T-H	r	47	15	3.13 · 1
H-T	r	10	1	10.00 · 1	T-H	r	29	8	3.63 · 1	H-H	r	48	15	3.20 · 1
H-H	r	11	1	11.00 · 1	H H	r	30	8	3.75 · 1	H-H	r	49	16	3.27 · 1
T-T	ω	11	2	5.50 · 1	H H	r	31	8	3.88 · 1	T-T	ω	49	16	3.06 · 1
H-H	r	12	2	6.00 · 1	T-T	ω	31	9	3.45 · 1	H-T	r	50	16	3.12 · 1
H-H	r	13	2	6.50 · 1	H H	r	32	9	3.56 · 1	H-H	r	51	16	3.18 · 1
H-H	r	14	2	7.00 · 1	H-T	r	33	9	3.67 · 1	T-H	r	52	16	3.25 · 1
H-H	r	15	2	7.50 · 1	T-T	ω	33	10	3.30 · 1	T-T	ω	52	17	3.06 · 1
T-T	ω	15	3	5.00 · 1	T-H	r	34	10	3.40 · 1	T-H	r	53	17	3.12 · 1
H-T	r	16	3	5.33 · 1	H-T	r	35	10	3.50 · 1	H-T	r	54	17	3.18 · 1
T-T	ω	16	4	4.00 · 1	T-T	ω	35	11	3.18 · 1	H-H	r	55	17	3.24 · 1
T-H	r	17	4	4.25 · 1	T-T	ω	35	12	2.92 · 1	T-T	ω	55	18	3.05 · 1
T-T	ω	17	5	3.40 · 1	H H	r	36	12	3.00 · 1	H-H	r	56	18	3.11 · 1
H-H	r	18	5	3.60 · 1	H-T	r	37	12	3.08 · 1	T-T	ω	56	19	2.95 · 1
H-T	r	19	5	3.80 · 1	H H	r	38	12	3.17 · 1	T-T	ω	56	20	2.80 · 1
T-T	ω	19	6	3.17 · 1	H-T	r	39	12	3.25 · 1	T-H	r	57	20	2.85 · 1
T-T	ω	19	7	2.72 · 1	H-T	r	40	12	3.33 · 1	T-H	r	58	20	2.90 · 1

Table IV

Chance alone can certainly account for wide variations in a small sample, but as the sample grows larger there is a kind of "averaging" out and the ratio tends toward the expected 3 · 1. Tom's aberrant ratio of reds to whites could be attributed to the chance combinations of genes, but with the size of his F_2 sample (167) such a hypothesis would seem to tax "credibility" a little.

. . . .

On the other hand, the ratio obtained from Tom's data is sufficiently divergent from comparable data presented elsewhere in this guide that it might be worthwhile to explore some of the pathways which might suggest explanations for the discrepant 3.79 · 1 ratio. Tom's problem is taken as a general case for discussion. What follows is not intended to be a treatise on all possibilities or to supply absolute answers. (In fact, some of the lines of argument taken conflict with one another.) Instead, the discussion which follows merely points out a few of the ways in which the best intentioned "fly breeder" could be led astray.

UNAUTHORIZED ADMISSION TO THE CLAN

There are a number of ways in which "happenstance" can affect the ratios from a genetic cross. Perhaps the most plausible experimental error in a cross of the red-white type would be to introduce both sexes for one eye color into the parental fly colony. Consider the cross of red-eyed females and white-eyed males. Suppose the initial colony is to consist of 12 females and 12 males, and by mistake 1 red-eyed male is included. The net result would be a colony consisting of 12 white-eyed males, 11 red-eyed females and 1 red-eyed male. In theory the 11 red females could be fertilized by any 11 of the males.* But, for the sake of argument, let us assume that the 11 females are fertilized by 10 of the white males and the lone red male (the red male probably has an advantage, anyway, in that he can see). Figure 20 shows an analysis of the 11 matings.

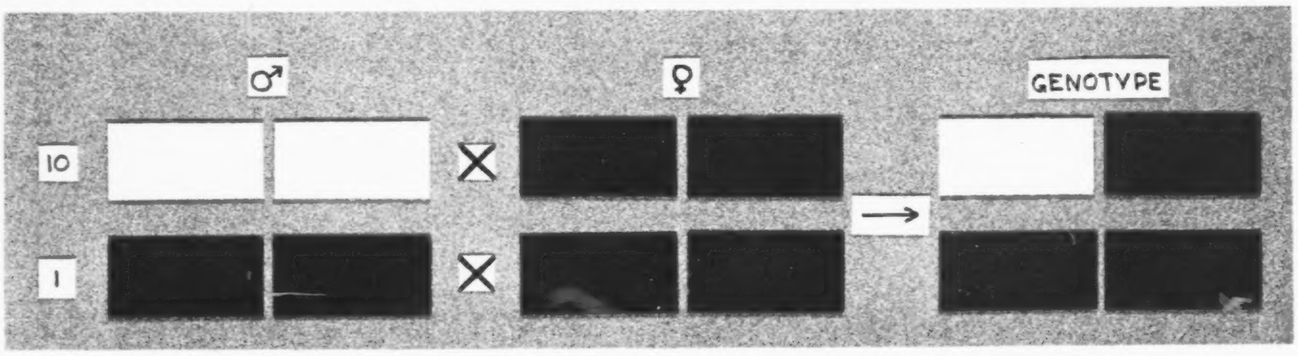


Figure 20

All of the F_1 will be red-eyed. Since female flies lay about the same number of eggs during their lifetimes, there should be 10 times as many heterozygous reds as there are homozygous ones.

---

*There is solid evidence that a female house fly is fertilized by only 1 male, and only once, during her lifetime.

The introduction of the 1 red male shifts the ratio of genes in favor of the red. In a normal cross of pure line reds and pure line whites, all of the F_1 would be heterozygous with each fly carrying a gene for red and a gene for white. If the F_1 offspring are then crossed, the colony would have a "gene pool" consisting of 50% genes for the red eye and 50% genes for white eye. In contrast, a colony of F_1 flies from the "aberrant" cross diagrammed in Figure 20 would possess a "gene pool" with more than 50% red and less than 50% white. Since the F_1 colony should have 10 flies heterozygous for red for every fly homozygous for red, it should be possible to make an estimate of the potential red-white ratio in the F_2.

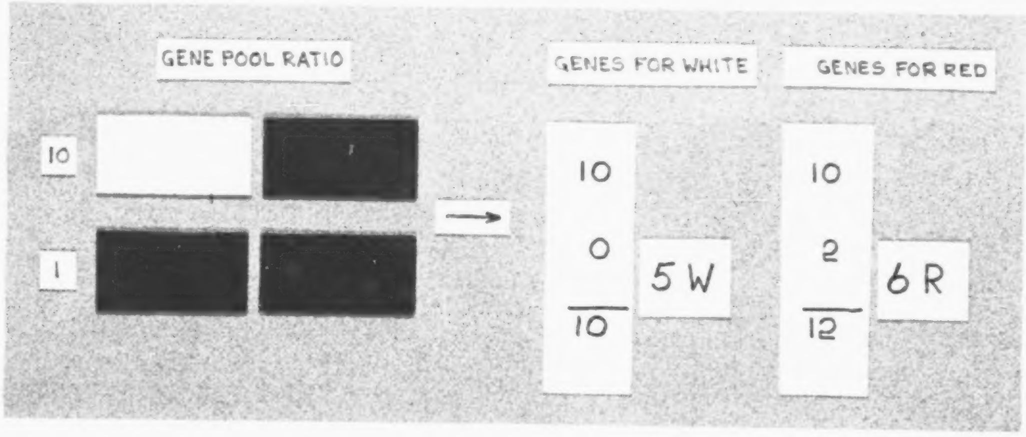
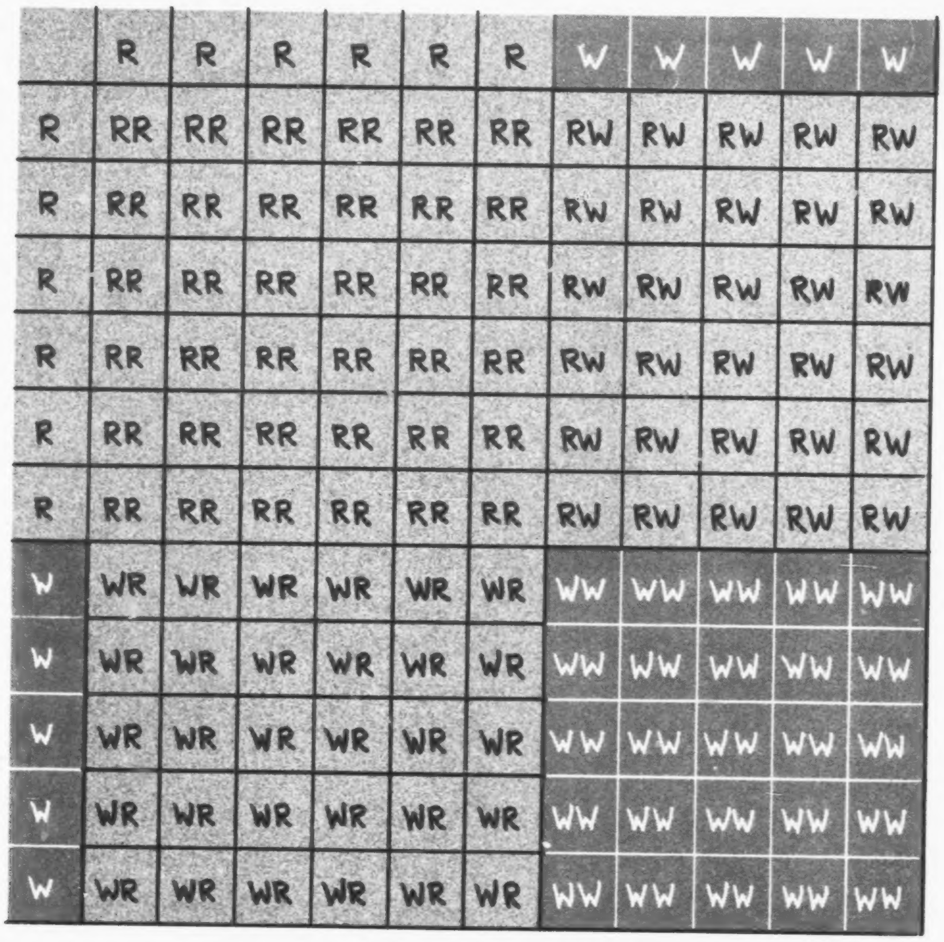


Figure 21

Both male and female populations in the F_1 should possess eye color genes in a ratio of 5W · 6R. By means of a large "square", one ought to be able to establish the "theoretical" numbers of red and white phenotypes in the F_2.



	R	R	R	R	R	R	W	W	W	W	W
R	RR	RR	RR	RR	RR	RR	RW	RW	RW	RW	RW
R	RR	RR	RR	RR	RR	RR	RW	RW	RW	RW	RW
R	RR	RR	RR	RR	RR	RR	RW	RW	RW	RW	RW
R	RR	RR	RR	RR	RR	RR	RW	RW	RW	RW	RW
R	RR	RR	RR	RR	RR	RR	RW	RW	RW	RW	RW
R	RR	RR	RR	RR	RR	RR	RW	RW	RW	RW	RW
W	WR	WR	WR	WR	WR	WR	WW	WW	WW	WW	WW
W	WR	WR	WR	WR	WR	WR	WW	WW	WW	WW	WW
W	WR	WR	WR	WR	WR	WR	WW	WW	WW	WW	WW
W	WR	WR	WR	WR	WR	WR	WW	WW	WW	WW	WW
W	WR	WR	WR	WR	WR	WR	WW	WW	WW	WW	WW

Table V

According to the data in Table V there will be 25 whites and 96 reds (60 of which are heterozygous). A simple calculation ($\frac{96}{25}$ = 3.84 · 1) yields, quite accidently, a ratio very close to Tom's.

BY SELECTION

There is another possible explanation for the aberrant ratio of reds to whites in Tom's F_2 generation. Our youngsters had acquired the habit of using the maggot migration technique for harvesting pupae (see On the Fly, p. 23 and The Fly Cycle, p. 2). About the fifth day after fly eggs have been inoculated into the larval culture medium, the mature maggots stop feeding and "search" for a place to pupate. If the opportunity presents itself at this time, the maggots will leave the culture dish and pupate elsewhere (Figure 22).

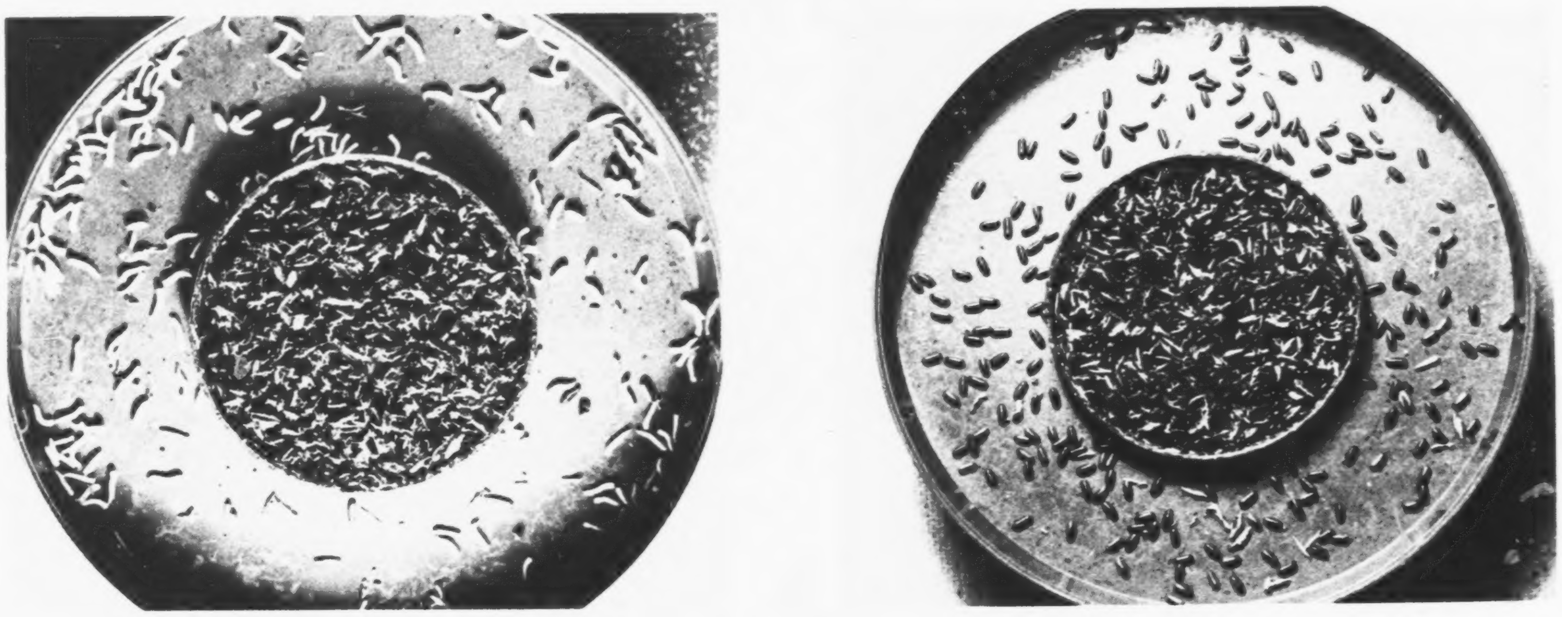


Figure 22

In the left hand picture the maggots are migrating from the culture dish and accumulating in the larger container. After a period of time, the maggots pupate (right hand picture).

Not all of the maggots migrate. A sample larval culture showed 75 pupae formed outside the culture dish, while 20 pupated in the larval medium. In general, the first maggots to migrate are the first to pupate (and are darker in color). The children usually harvested these pupae, leaving behind the younger, lighter pupae, the unpupated maggots, and pupae formed in the larval medium by non-migrating maggots. Furthermore, they started their cultures with flies which had been selected on the basis of first emergence from the pupae they harvested.

We wondered what the distribution of whites and reds might be if one "trapped" each maggot when it migrated from the medium, put it into a numbered pill box, and observed the type when the adults emerged from the pupae. One could pick off each maggot as it migrated, provided, of course, that one was willing to sit up all night and wait out a couple of hundred fly maggots. This "maggot-sitting" would not be too bad for one night -- or even two, but the task appeared to be more extensive than this. We chose to improvise a piece of apparatus which would "maggot-sit" for us and would turn itself off when the chore was finished.

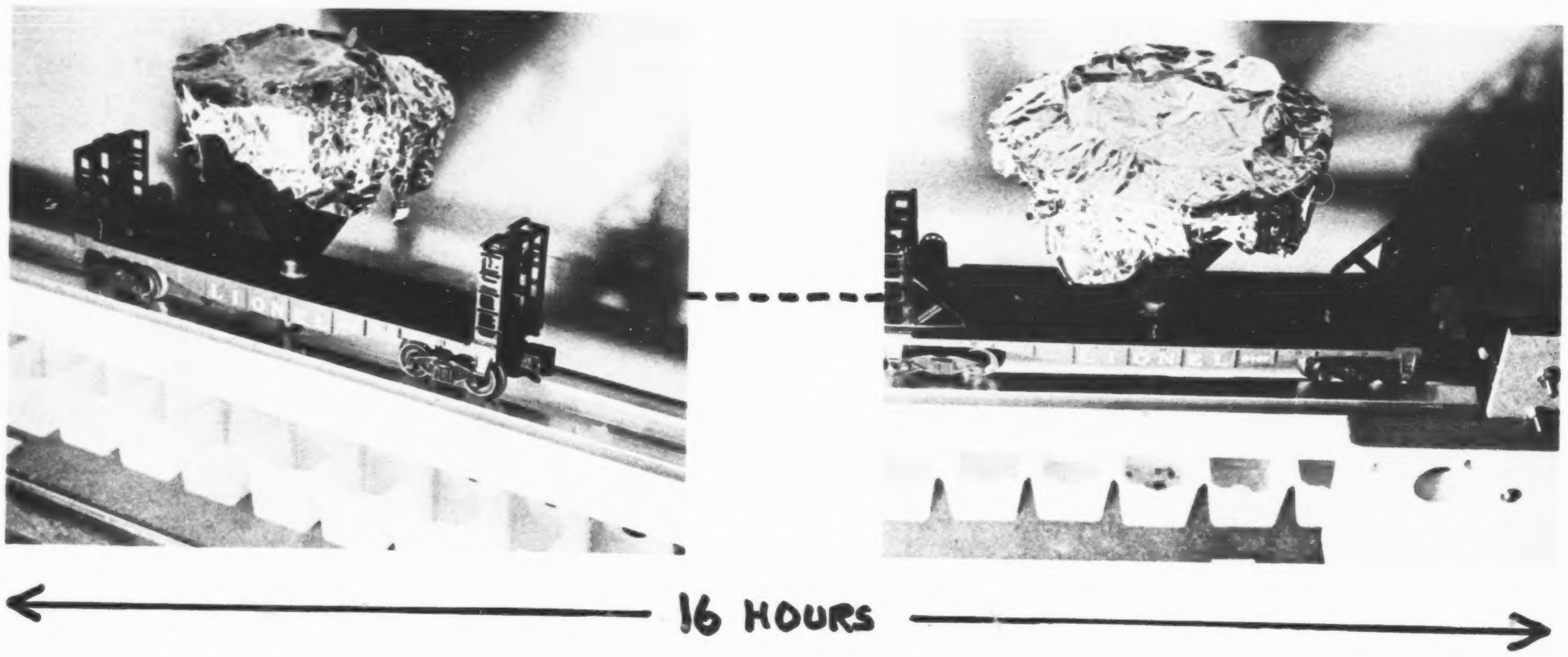


Figure 23

An "O" gauge model railroad flat car is fitted to a track made of aluminum angle bends. At one end of the track is a clock-motor mechanism which is connected to the flat car by a piece of heavy thread. Underneath the track center is a continuous line of individual ice cube cups. The funnel atop the car contains a Petri dish culture in which the maggots are ready to migrate. As the maggots crawl out of the larval medium, they drop into the funnel and fall down into a waiting ice cube container. While this process is repeated over and over again, the car is being drawn along the sixteen foot track by the clock motor at a rate of about one foot per hour. When the car reaches the clock motor, it trips a switch which shuts off the motor and stops the car.

With a device of this type it is possible to order the majority of the maggots (not all migrate) in a linear series according to time of migration. The maggots are then put into plastic pill boxes where they pupate in a few hours and, six or seven days later, emerge as flies. The order of pupation is approximately the order of migration, and the order of adult emergence is approximately the order of pupation. We wondered if we would see any unusual concentrations of red or white-eyed flies anywhere in the series.

The experiment was carried out with eggs collected from a single F_1 female which had been fertilized by one of her "brothers". All of her eggs were laid within a 30 minute period and, hence, were approximately the same age. The eggs (137) were inoculated into larval medium immediately. Four days later the culture dish was placed on the maggot migrator and the mechanism started. Later analysis showed that the culture dish produced 114 maggots, 101 of which migrated and were trapped in linear order. Thirteen maggots did not migrate and formed pupae in the medium. Twenty-three eggs either failed to hatch or the resulting larvae died before reaching the mature maggot stage (see p. 32). The 114 pupae eventually produced 21 white-eyed flies and 85 red-eyed flies (an unusually high ratio of 1 · 4. 05); no flies emerged from the other 8 pupae. Once the flies started emerging, the pupae were examined every hour or so and classified. Table VI summarizes the results of the first 29 maggots to migrate.

CUP	PUPAE	FLIES	A.M. 11:30—P.M. 12:00	P.M. 12:30	P.M 1:00	P.M. 2:15	P.M. 4:30	LATER
1	10	8	ww rrrr	r	r			
2	1	1		r				
3	4	3						rrr
30	1	1	w					
39	1	1	w					
40	1	1	r					
42	2	2			r			r
43	1	1					w	
44	1	1	w					
49	1	1	r					
51	1	1					w	
52	2	2		r				r
56	2	2	w r					
57	1	1						r
	29	26	7r · 6w	10r · 6w	12r · 6w	12r · 6w	12r · 8w	18r · 8w
			1.17 · 1	1.67 · 1	2 · 1	2 · 1	1.5 · 1	2.23 · 1

Table VI

Table VI presents the data in two dimensions: vertically in order of migration and horizontally according to the time of fly emergence. Thus the white-eyed fly (red box) hatched from a pupa formed by the 21st maggot to migrate. This was the only maggot to drop into cup no. 43. This white-eyed fly was either the 19th or 20th fly to emerge (4:30 column). Progressive fly totals and ratios are tabulated at the bottom of the table. Time intervals between ice cube cups may be approximated based upon a rate of 10 cups traversed per hour. Thus the 21st maggot migrated approximately 4 hours and 20 minutes after the experiment was started.

The most interesting pattern in the abbreviated table is the appearance of 6 white-eyed flies in the first 13 flies to emerge, a ratio of nearly 1 white · 1 red. Almost 29% (6/21) of all the whites in the adult population appear in 12.5% (13/108) of the total population. Perhaps chance could account for this "skewing", but it seems much more economical to attribute it to developmental differences in the two phenotypes. It might be interesting to set up an analogy experiment to compare results obtained by "chance" with this 6 · 7 distribution.

One might, for example, put 21 white marbles, 85 red marbles and 8 of some other color (unhatched pupae) in a bag, and then withdraw 29 of the marbles at random and place them in a second bag (any type of uniform object could be used). Thirteen of these could then be withdrawn and classified. How many tries would it take to obtain 6 whites and 7 reds? The pupae which failed to produce flies present a slight problem, in that they cannot be distributed "honestly" on the time scale. Perhaps it would be best to omit them or withdraw marbles from the second bag until 13 red and white marbles have been accumulated.

Strangely enough, the 4.05 · 1 ratio of reds to whites obtained from the F_2 in this experiment is even more deviant from the expected 3 · 1 ratio than was Tom's ratio. One has to believe that more than half of the 23 eggs "lost" in the larval culture would have produced white-eyed flies. (See COMPETITION IN THE LARVAL MEDIUM, p. 32.)

THE NUMBERS GAME

When F_1 flies from a red and white pure line cross are mated among themselves, the Mendelian model allows one to predict the "ideal" numbers of F_2 genotypes and phenotypes for a given sample. Thus, 3/4 of the F_2 flies will show the red phenotype and 1/4 will show the white phenotype, with 2/3 of the red-eyed flies carrying a gene for white eye and the other 1/3 being pure line for red eye. Furthermore, these phenotype and genotype ratios will be distributed in the same manner between the two sex classes, male and female. (On the average our laboratory strains of house flies usually give approximately equal numbers of males and females.) When one considers all of these factors for a given sample, an imposing array of numerical ratios is involved (1 · 1, 3 · 1, and 2 · 1). What number of flies can accomodate a "perfect" distribution? We decided that 24 would work nicely (it has nice factors, 12 · 2, 8 · 3, 6 · 4, 24 · 1). We then selected 24 pupae at random from the total harvest (106) of a single Petri dish larval culture. We wondered what kind of "goodness of fit" would be obtained when the adults from the 24 pupae were classified and the results compared to the "ideal" predicted by the Mendelian model.

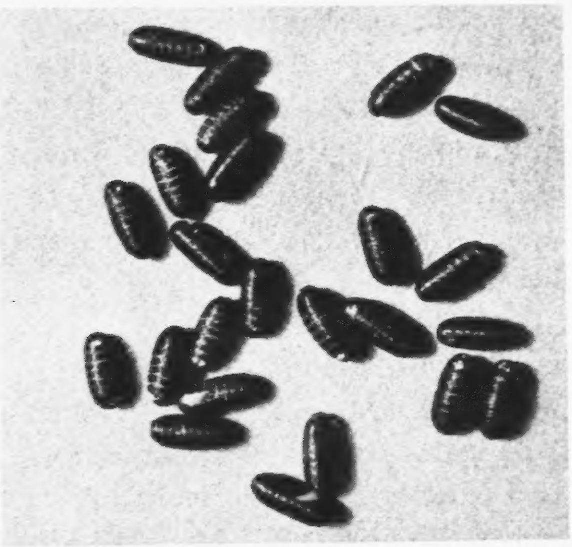


Figure 24

The 24 pupae shown in Figure 24 were selected at random from 106, the total harvest from a plate culture. One wonders how the "count" of adult flies emerging from these pupae will fit the expected numbers in each class.

Figure 25 shows the "ideal" expected results, taking into account sex, phenotype and genotype.

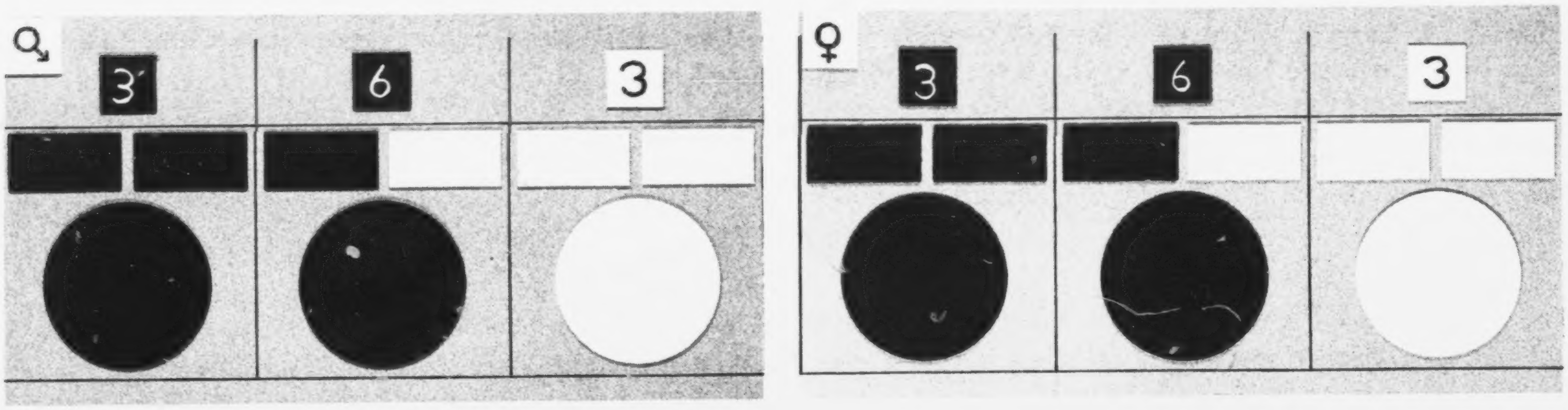


Figure 25

Figure 26 shows the actual results obtained by classifying the adults which emerged from the sample of 24 pupae. (One pupa failed to produce a fly.)

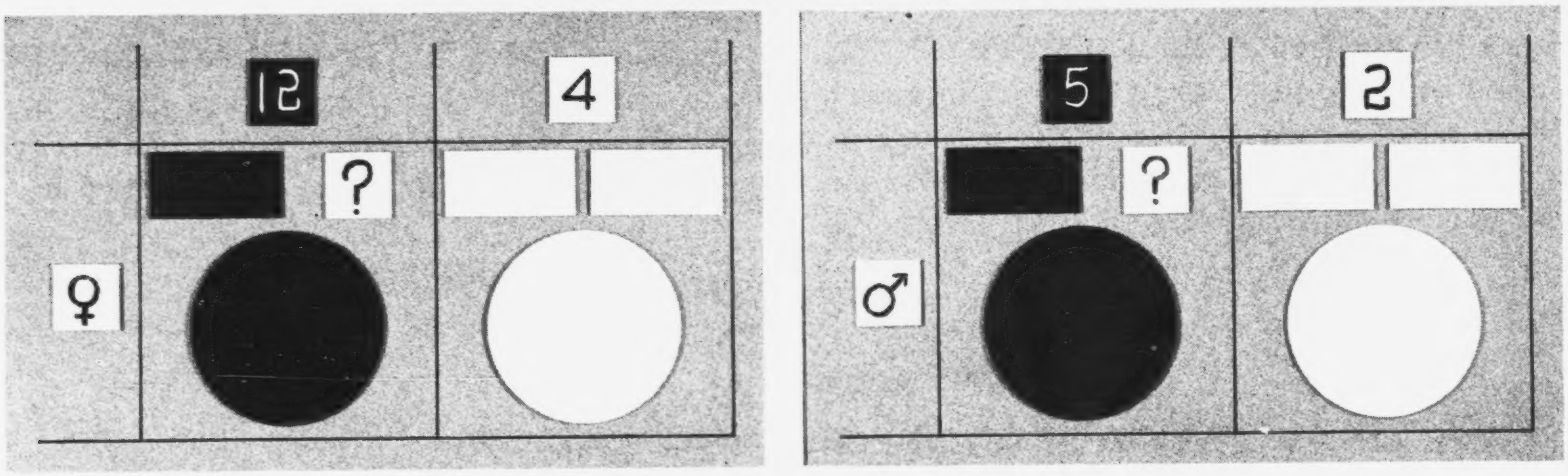


Figure 26

The "fit" of the results to the ratios predicted by the model is not too bad. The 3 reds · 1 white ratio holds up as well for each sex as for the total results. The sex ratio, however, varies quite widely from the expected ratio. When the total population (106) from which the 24 pupae were sampled was classified and counted, the sex ratio looked more "respectable"; the results showed 58 females and 44 males, of which 77 were red-eyed flies and 25 were white-eyed flies.

In house flies it is impossible to distinguish a pure line red-eyed fly from one which is red-eyed but carries a white factor. Unlike shorthorn cattle, the heterozygous condition does not show in the phenotype. For this reason all of the reds in each group are listed together in Figure 26 . To determine which of the red-eyed flies are pure line and which carry a white factor, an additional cross is required. We made this cross using the 12 red females of unknown genotype and the 7 white males (plus three or four others) known to carry two genes for white eye..... that is, they were white-eyed.

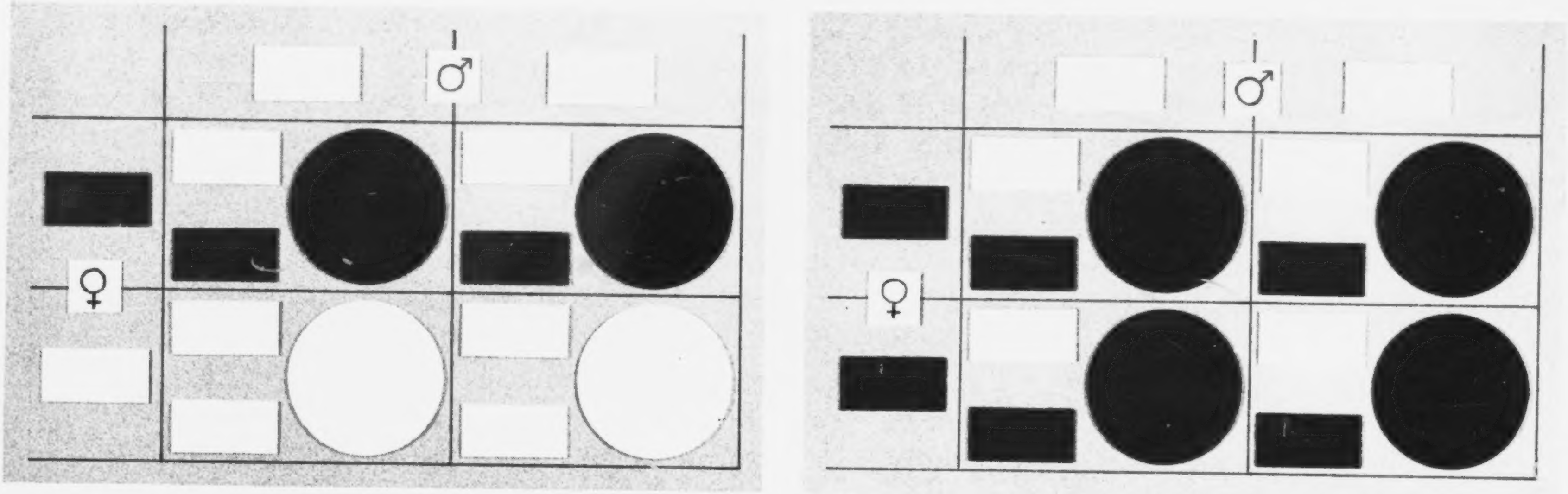


Figure 27

Geneticists refer to this type of breeding as a test cross. The red-eyed females could be either homozygous or heterozygous for red. The diagram on the left shows a test cross with a heterozygous female, while the one on the right shows a white-eyed male being crossed with a homozygous red-eyed female. Only if the red-eyed parent can contribute a gene for white eye will white-eyed flies show up in the offspring..... in which case half of the flies will be white-eyed and half phenotypically red but carrying a gene for white.

After the white males had fertilized the red females, we isolated 3 pregnant flies and collected the eggs of each individually. According to the Mendelian model, 2 out of the 3 females should carry a white factor. When we examined the offspring of each female, this turned out, by chance, to be the case. One of the females produced only red-eyed flies, while the other two produced approximately half reds and half whites (69 reds · 54 whites, and 27 reds · 28 whites).

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COMPETITION IN THE LARVAL MEDIUM

In the laboratory cultures fly eggs hatch and produce tiny larvae in the "tight" quarters of a small container. The more eggs that are put into a given quantity of larval medium, the more crowded the conditions become for the young larvae. Since there is no possibility of migrating to new food sources and/or a less congested medium, all must live or die within the boundaries defined by the culture container. At low larval densities competition between larvae is minimized. But as the number of larvae per unit of medium increases, competition can become a critical factor. Only larvae which reach the maggot stage and pupate have a chance to be "counted" in the adult population.

Eggs from the F_1 females (and the larvae and flies they eventually produce) can have three different genotypes, RR, RW, and WW. Any significant biological differences reflected by these different genotypes could be advantageous or detrimental to the developing larvae in a competitive environment. In a crowded culture where many larvae must die, a kind of "survival of the fittest" situation could prevail. For example, if the white eye genotype (WW) gives the larvae some developmental advantage over the red eye genotypes (RR and RW) in terms of survival in a competitive larval culture, then a higher ratio of whites to reds might be expected than the 1 · 3 predicted by the Mendelian model.

On several occasions we have inoculated large numbers of eggs into relatively small quantities of larval medium (random eggs from F_1 colony "pools") to see if the red-white ratio could be shifted significantly by competition between the various genotypes present. The results were mostly inconclusive. But in one instance a significant shift seems to have occurred. This culture produced 169 reds, 96 whites but had 126 pupae which did not "hatch". In addition, the fifth grade class at Community School got similar results. Inadvertantly, they had inoculated a large number of eggs (all eggs produced by one colony in one day) into a Petri dish of larval medium. From this culture they harvested a large number of pupae, boxed them, and classified and counted the reds and whites. Their results showed 169 red-eyed flies and 81 white-eyed flies. In both instances one could hypothesize competition and selection as a cause of the aberrant ratio.

One way to avoid the vagaries of the competition-selection problem would be to use a small number of eggs, say 100, and hope that each egg would produce a fly. If one-to-one correspondence between eggs and flies could be established, then larval competition could be eliminated as a possible cause of aberrant ratios. In practice, however, some eggs will not hatch into larvae. And no matter how low the larval density, some larvae always seem to die off during the four day development period. In our laboratory we have found that Petri dish cultures yielding fewer than 100 pupae usually produce "respectable" ratios of reds to whites..... but this is a "rule of thumb" rather than an experimentally proved technique.

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On the Fly

some notes on the house fly... and its interaction with children

Williams
Carol
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Pa

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A publication of the Webster Institute of Mathematics Science and Arts (WIMSA), Webster College, Webster Groves, Missouri. This work was supported in part by a grant from the Carnegie Foundation.

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PREFACE

This is the first of four documents on the house fly to be published by the Webster Institute of Mathematics, Science and Arts. All are the result of experimental work with various age groups on the Webster College campus. Even Flies Remember, an informal approach to heredity and genetics; Bringing the Mountain to Mohammed, a pre-Lavoisier approach to the chemistry of the atmosphere; and The Continuous Laboratory Approach, a part of our new phenomenological approach to beginning biology, are the other works.

On the Fly was developed in conjunction with the fourth and fifth grades in the Webster College Experimental School. Five Webster College students: Miss Dianne Dignam (senior), Miss Betsy Dum (freshman), Mrs. Helen Eckelkamp (junior), Miss Dorothy Higdon (freshman), and Miss Carole Marks (sophomore), colloborated in doing the bulk of the trial teaching. All had had an experience, in depth, with the house fly before they undertook to work with elementary school children. In addition, the house fly has been used in numerous classrooms in the St. Louis area by teachers who are involved in the Webster College Master of Arts in Teaching program. The approach these teachers used has been for the most part their own. Our laboratory has supplied the flies and some apparatus, as well as the basic technical information on house fly husbandry.

I would like to give particular thanks to Sister Carl Marie Mueller, Director of the College School, and to Sister Jacqueline Grennan, President of Webster College. I am grateful to Sister Carl Marie because she extended the concept of flexibility in school organization to accommodate the eccentricities of the "curriculum innovator," and to Sister Jacqueline because her "philosophy in action" has set the overall tone for experimental work at Webster College.

Our thanks is also extended to Dr. W. W. Kilgore of the University of California at Davis. Exposure to his research on chemosterilants prompted us to utilize the house fly as an organism for classroom study.

No document gets much beyond paper and pencil scratchings without a lot of effort by capable people. My empathetic thanks go to (Mrs.) Geraldine McKelvey who typed the manuscript and to Miss Jackie Dotta who provided editorial assistance.

On March 31, a classroom film, A Linear Look at the Fly, was produced with the indispensable aid of sixteen fourth and fifth graders from the Experimental School. We cannot give sufficient thanks to the parents of these children for their confidence and trust. They provide us with the paramount element in experimental teaching, children. The film, along with a teacher commentary, will be available from WIMSA in October of 1966.

Paul D. Merrick

Webster College
May 28, 1966

ON THE FLY

ERRATA SHEET

Page 2: Four lines from the bottom - "literally" should read "figuratively"

Page 8: B. Wet Mix
Line two - "50cc" should read "500cc"

Page 16: Fourth line under the Figure - "plates shown" should read "plate shown"

Page 30: First line - "working with out" should read "working with our"

Fourth line - should read "She found a pupa"

Page 31: Fourth line - "31" should be after "Figure"

- - - - - - - - - - -

INTRODUCTION

Insects display a fascinating variety of life cycles. Unlike man and most other mammals where fertilization of the egg is followed by a more or less continuous development terminating in the adult organism, insects such as the house fly undergo a series of discontinuous stages en route to maturity. The complex life cycle of the house fly offers an excellent vehicle for the study of life processes by elementary school children.

Almost everything the fly does may be observed if it is housed in a proper cage. The house fly spends its entire adult life in the open, feeding, breeding, egg-laying, and dying. He is large enough to watch without eyestrain, yet small enough to make the task of culturing him simple. The fly is an animal that every human knows through intimate contact; he is our constant companion. We should get to know him better and through this knowledge come to understand more about life itself.

While the fly materials were being trial-tested in the College School, the children worked in small groups. Each group was shepherded by a student from the College and backed up by the facilities of our own fly laboratory. Some of the things which were done in the trial classes would probably be difficult to do in many other classroom situations. For example, all forty-two children in the experimental classes maintained their own fly "colonies," and, indeed, some maintained two or three.

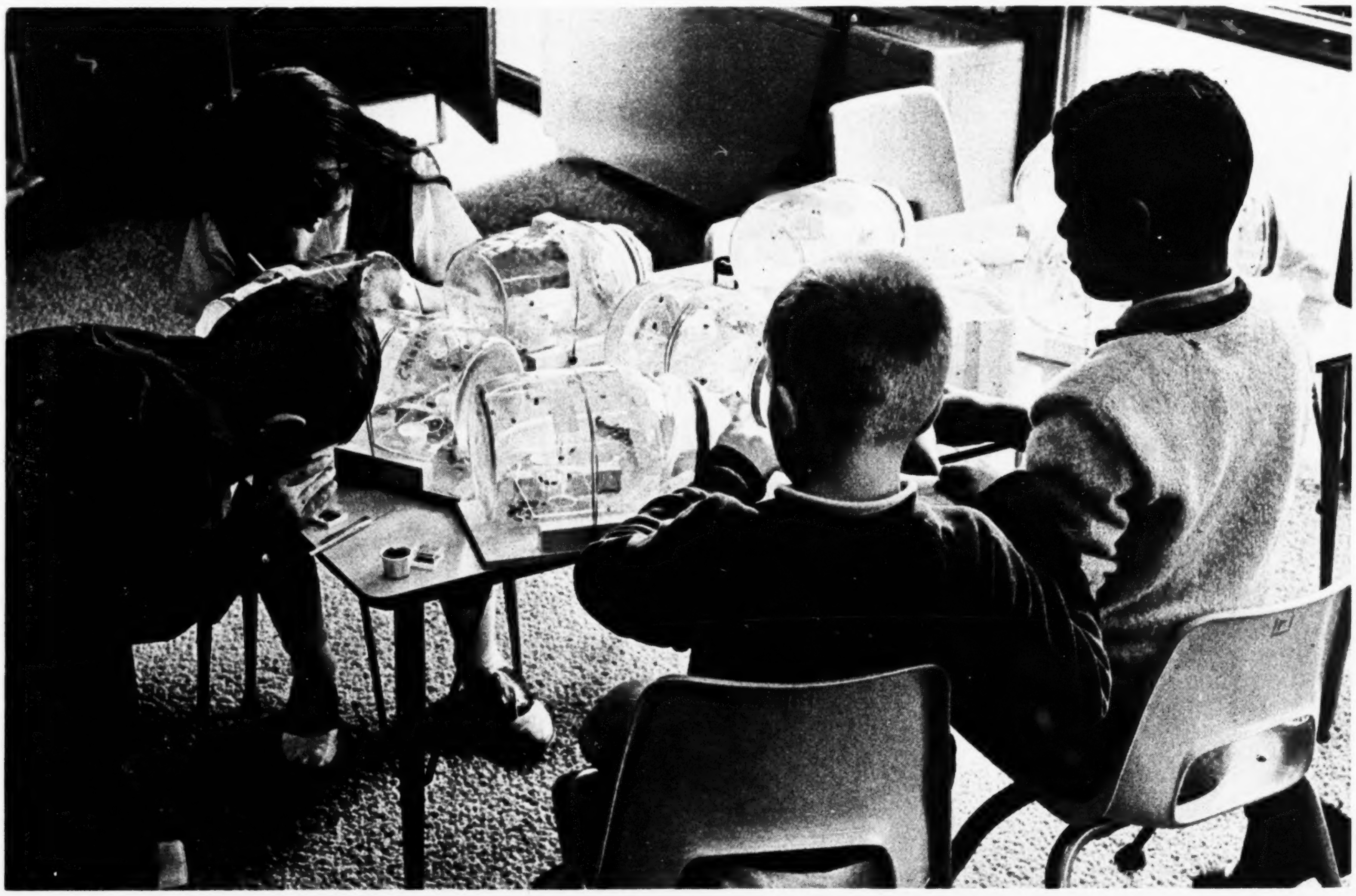


Figure 1

The children worked individually and in small groups.

This is fine for people involved in the innovation of curriculum materials; but it may well be unfeasible in a classroom where the ratio of teachers to children is usually about thirty to one. We do think that our experimental teaching experiences did, however, establish clearly that children could be captivated by the lowly fly, and that they can culture this organism without undue difficulty.

No one could seriously entertain the idea of writing a guide for the study of the house fly and consider that it would offer the one "true" pathway. The culture of any organism offers unlimited possibilities with regard to emphasis, highways and by-ways for exploration, time involvement, and approach. It seems to me that the most profitable thing one can do in a guide such as this is to relate some of the basic husbandry procedures, indicate some of the "milestone" experiences from the trial classes, relate some significant anecdotes, and provide relevant technical data.

The guide relates practical information useful to anyone who wishes to take the "plunge" and let children look at life on the "half-shell" in the form of the house fly. We have cultured (perhaps endured is the word) more than half a million flies during the past nine months. As a result of this experience (and perhaps in spite of it), we have evolved certain techniques, mostly by trial and error methods, which may be helpful to teachers who utilize the house fly in their classrooms.

ORGANIZATION OF THE GUIDE

The guide is divided into three more or less distinct sections. The first of these deals with basic cultural techniques for starting and sustaining a stock culture of house flies. The procedures suggested are conservative; and, followed with reasonable fidelity, success will occur far more often than failure.

The second section of the guide discusses some "selected" experiments we developed in the trial classes. The selection is neither complete nor are the activities suggested essential to the successful culture of the fly. We offer them as "food for thought" in the hope that they will catalyze you, the classroom teacher, to innovate your own scheme.

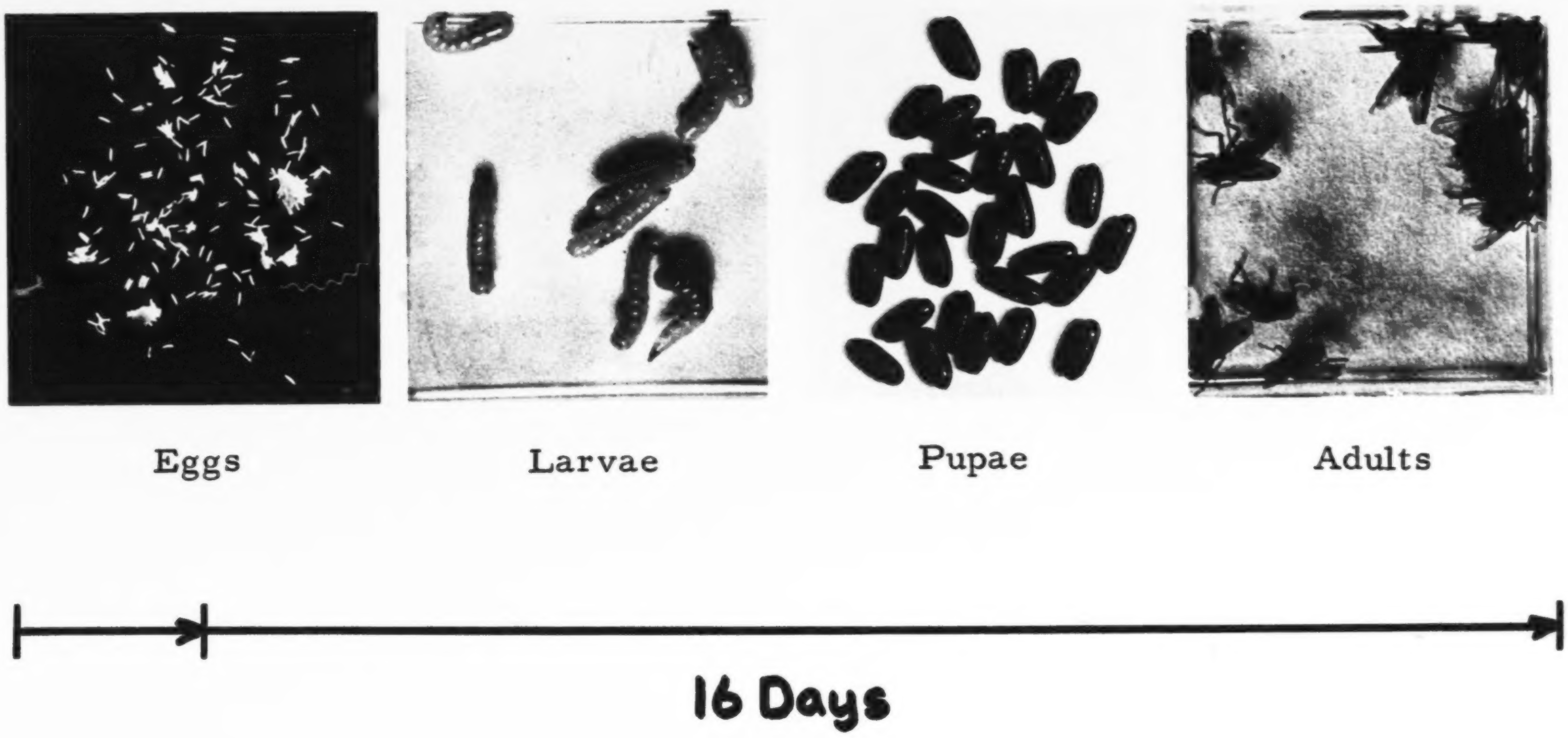
The third section is an Appendix. Like most Appendices it consists of a polyglot collection of ideas that the author could not fit elsewhere in the guide. Here we offer additional technical information, some variations on the cultural theme, observations by children..... and a few paragraphs which may stretch poetic license to the breaking point.

. . . .

Hundreds of students at Webster College have enjoyed getting to know the fly better. He grows on you..... literally speaking, of course. We hope you will find these materials useful in your classrooms and, above all, enjoyable to use. Remember though, this guide consists of a series of "primer" suggestions and guideposts; it is not a course of study.

STARTING A HOUSE FLY CULTURE

The house fly is an easy organism to culture under classroom conditions. During its life cycle (approximately sixteen days from egg to egg), the house fly displays four distinct stages, all of which are readily observable and easy to manipulate. In theory, one could start a culture with eggs, larvae, pupae, or adults, since each stage harbors innately the potential to keep the cycle going.



Eggs Larvae Pupae Adults

Figure 2

Fly eggs are tiny, however, and difficult to identify in the natural world. It has only been a few hundred years since Francesco Redi demonstrated that flies did not originate spontaneously from non-living things. The association of fly eggs with maggots is of even more recent vintage. (I remember quite vividly the first time I ever saw fly eggs. I was cleaning some rainbow trout when a female fly boldly deposited a clutch of eight or ten eggs on the side of one of the fish.) Maggots (mature larvae) and adults are easier to find, the maggots because they wiggle and squirm in a manic manner when their environment is disturbed, and adults because they are man's constant buzzing companions in every nook and cranny of his globe.

For every fly there must have existed a pupa; but since the pupae are immobile, dull reddish-brown in color, and "seed-like" in appearance, we probably do not recognize them as incipient flies. Methods for trapping adult flies and using maggots and eggs as starting points are discussed in the Appendix. We will use pupae as a starting point for the purposes of this discussion.

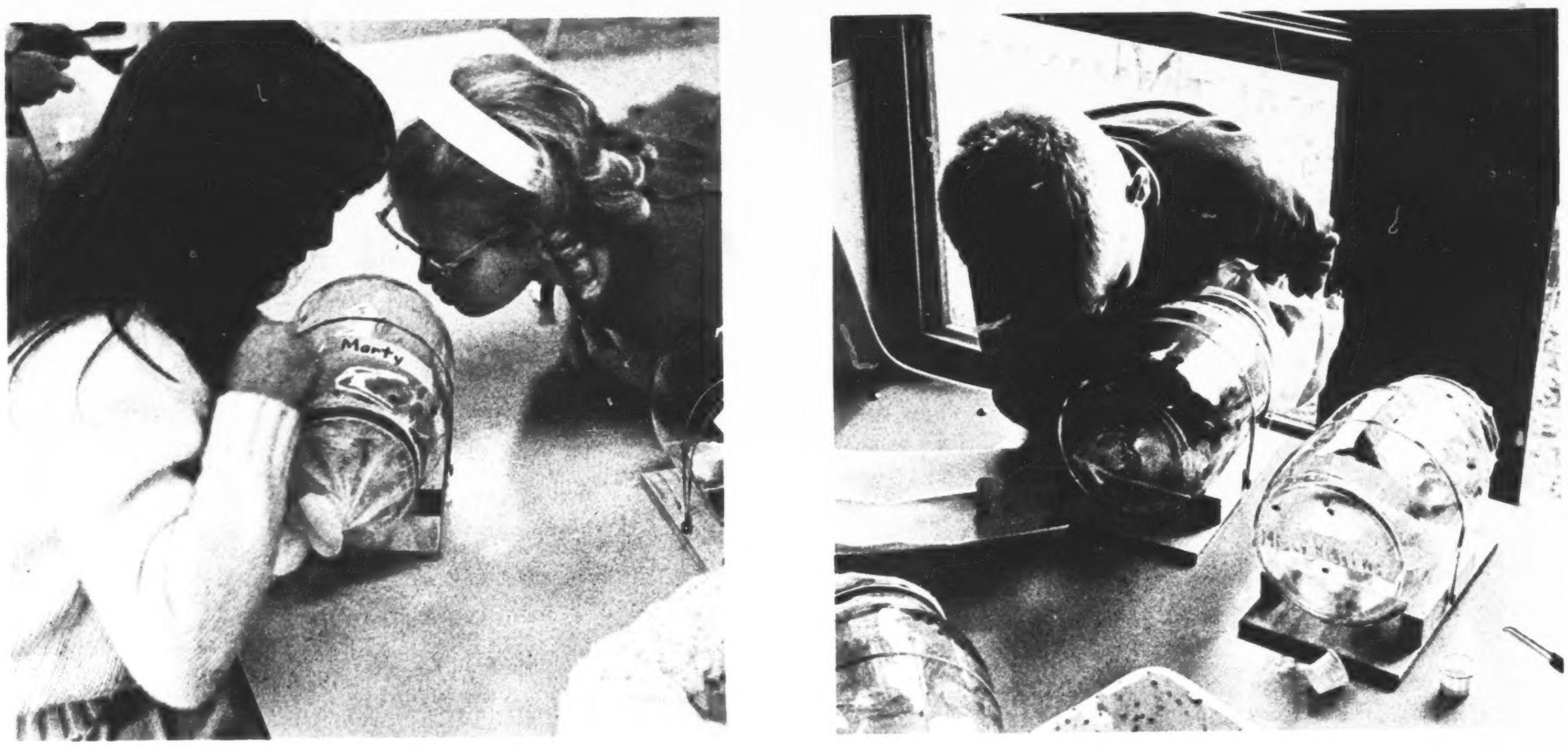
Once the cultural cycle has been established and pupae are available from stock cultures, the method of choice for student use in the classroom is to put fifty or sixty pupae inside a suitable cage and let them emerge "contained." One has to invest a little effort to separate the pupae from the medium in which they are cultured, but the pay-off is high in terms of random culture practices by inexperienced youngsters. The advantages of starting fly cultures with pupae are extremely practical ones. Pupae can neither wiggle away nor fly away, and they can be shipped as pupae from anywhere in the United States..... and arrive at their destination as pupae. For six or seven days the new fly-to-be remains immobilized, imprisoned in a cell of its own making. Then, in one "super-fly" effort it flips its lid and emerges as a non-flying adult. If the newly-emerged house fly catches you without a cage or suitable container, you have only a few minutes to solve the problem before the free population in the room (N) becomes N + 1.

Flies require food, water, air, and a cage. The cage is not an absolute requirement from the fly's point of view, but to some humans..... well, some people are just fussy about this sort of thing. So to keep everyone happy we suggest that you make a serious effort to confine your house flies to their own little "ghettos".

After much trial-and-error experimentation and several glaring failures, our laboratory at Webster College has come up with a cage that is functional and can be made from materials available locally.

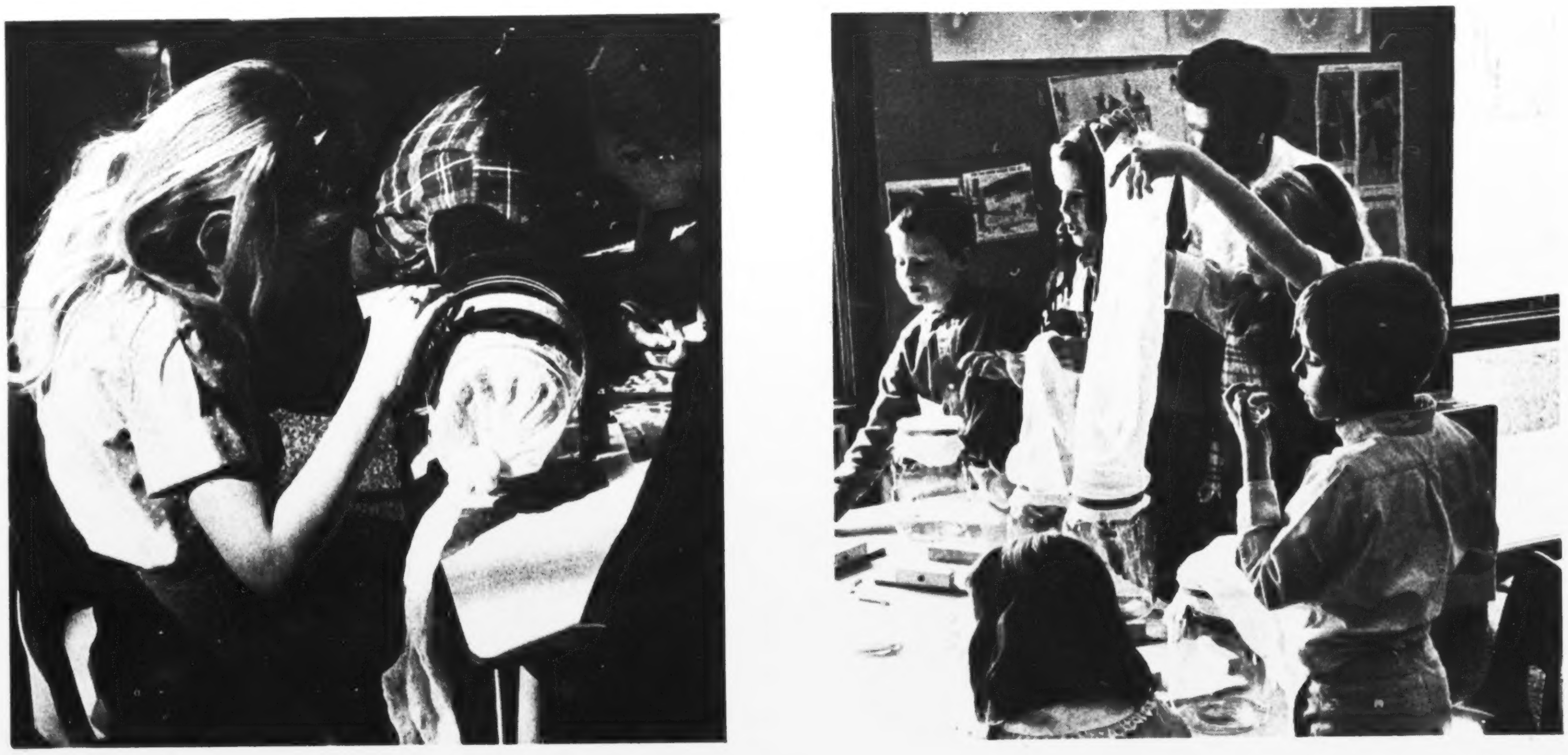
The cage is functional.....

.....even for "southpaws"



Provides for unlimited visibility

Even in poor light



Hand lens has new utility

Easy to make

Figure 3

A glass cage allows for unlimited visibility and can be washed out easily. The plastic plate with holes drilled through it provides a stable platform for feeding and egg-collecting cups. Fine mesh gauze (24 x 24 grade) is excellent for the sleeve and cheap enough to be disposable. (A woman's silk stocking or a man's shirtsleeve are good substitutes.) (See Appendix for cage details.)

Once you have adult flies the problem of feeding and general maintenance rears its head. Newly-emerged flies will live twenty-four to forty-eight hours after emergence from the pupal stage. If thirst and starvation are prolonged much beyond this point, however, the flies begin to die off. In nature, flies have to catch what they can when they can; thus they will survive quite well on a wide variety of diets. Sugar water, for example, will sustain a colony as well as any other diet, although females will not lay eggs. Most fly laboratories throughout the country use a milk diet of one kind or another. One common diet is a mixture of one part canned milk with four parts water; this provides both food and water in a single mixture. The chief drawbacks of this diet are odor and the refrigeration requirement. Unless the milk-water mixture is changed daily, souring occurs; and the odor can become offensive after a couple of days. The other standard diet is dried milk and water, fed in separate containers. Flies do slightly better on the liquid milk diet, but the difference is hardly noticeable.

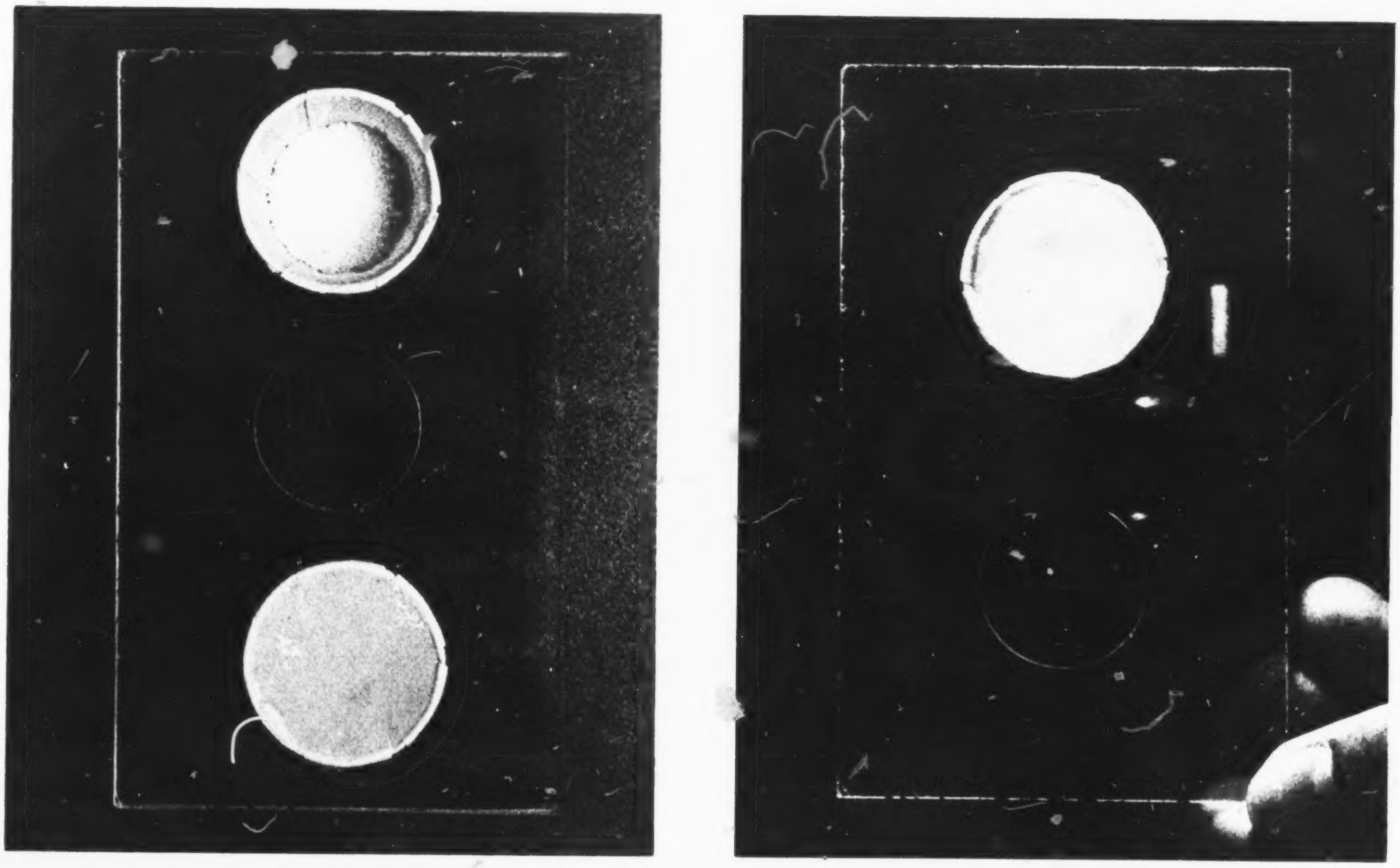


Figure 4

Half-ounce "souffle" cups work very nicely for food and water. Where liquids are used, the cup should be filled with cotton first, and then flooded with milk or water. The cotton matrix helps prevent flies from getting trapped in the liquid. Since the gallon jar is positioned horizontally, it is necessary to provide a platform to prevent spillage of food and drink. With dried milk a "three-holer" is required, while liquid milk needs only a "two-holer". In each case the extra hole is provided for an egg cup (See page 8).

THE EGG STAGE

If a colony is started from pupae, one will usually find eggs by the fourth or fifth day after the flies have emerged..... provided, of course, that the colony contains both males and females. Colonies with high fly densities produce eggs more rapidly than colonies containing few flies. "Pregnant" females (gravid) are apt to lay their eggs anywhere in the cage, although they seem to seek out a "tight" place for ovipositing. The eggs are passed out through the ovipositor which can be extended from the tip of the abdomen. Frequently, female house flies deposit eggs from an eighth of an inch to a quarter of an inch from the maximum point they can reach with their abdomens.

With a little sleight of hand, flies can be "trained" to lay all of their eggs in one basket.

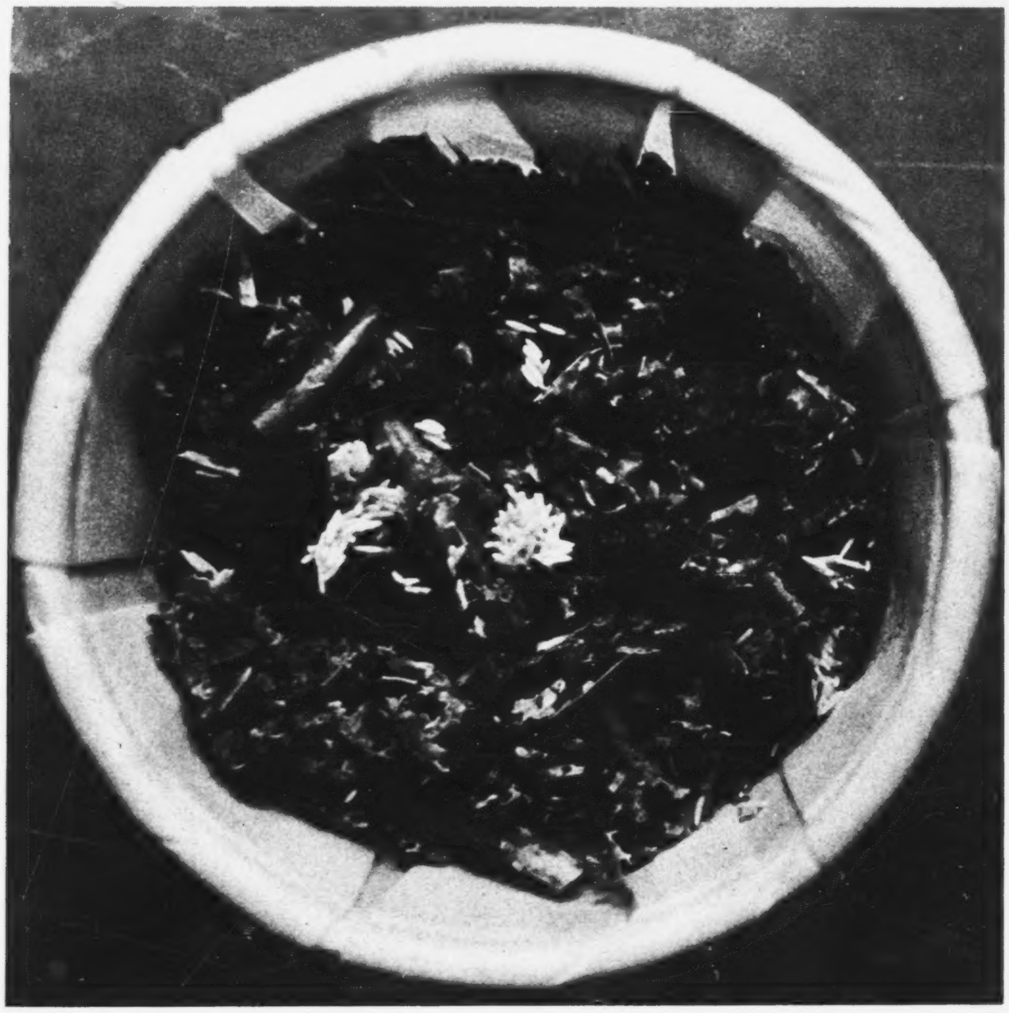


Figure 5

The "souffle" cup has been filled with a mix used for culturing larvae (Recipe on page 8). Egg cups should be put in the cage daily, starting with the fourth day after the flies have emerged from the pupae. Eggs are generally deposited below the surface of the medium and need to be uncovered with a probe.

It is a good idea to change the egg cups daily. Once the flies start ovipositing, there will usually be eggs in the medium each day. It is not uncommon to see the entire surface of the medium covered with ovipositing females. An average gallon jar colony may contain twenty or thirty females; and, at times, they may lay several thousand eggs. Usually, however, there will be a couple of hundred eggs each day.

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THE LARVAL STAGE

When fly eggs are deposited in a moist environment, they usually hatch into larvae in twelve to twenty-four hours. Some eggs will persist a good deal longer under room conditions, and fresh eggs can be stored in a refrigerator for up to forty-eight hours without too much drop-off in viability. All things being equal, however, it is much better to innoculate the fresh eggs into larval medium as soon as possible. Young larvae will survive quite well in fresh media.

The larval medium technique to be described here is commonly used in fly laboratories throughout the country. Many ad hoc preparations will produce good results; but for continuous success we recommend the procedure outlined below. No biological system behaves exactly the same way each time, and this larval culture technique is no exception. We have had occasional failures which were unexplainable; but, in general, it is a reasonably fool-proof technique.

A. Dry Mix
Weigh out 350 grams of C.S.M.A. Fly Larval Medium* (a one pound coffee can heaping full is a practical equivalent). Crushed dog food can be substituted, but it is not as reliable nor as easy to handle for pupae recovery and can develop an extremely offensive odor.

B. Wet Mix
Mix 7 grams of dry yeast (one package) with 20cc of grocery store molasses (two tablespoons full) in 50cc of water (one pint). Disperse the yeast and molasses in the water by shaking the mixture vigorously.

C. Pour the wet mix into the dry mix. Work the mass with your hands until it is thoroughly mixed and wet. The medium is now ready for use. It can be stored, however, if the container is loosely covered. After forty-eight hours, it is a good idea to discard it and make up a new batch.

Figure 6

It feels good to get your hands into something substantial!

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*Available from Ralston-Purina Co., Kansas City, Missouri ($3.00 per 75 lbs.)

ALTERNATIVE MEDIA FOR CULTURING FLY LARVAE

The larval culture technique described in On the Fly (page 8) assumes the availability of Ralston Purina fly larval culture mix locally. In many areas this product is difficult to obtain, or the process of obtaining it is so lengthy as to provide a "barrier" to culturing flies in the classroom.

We have tested many substitutes for the Ralston Purina mix. Most have proven to be unsatisfactory. Two have been found which produce consistent results and are available everywhere. Both are excellent for small scale larval culture as in deep Petri plates or small cans or other containers.

A. Bran-Milk Method

1.) Dilute 1 part canned milk with 4 parts water.

2.) Mix 1 volume of diluted canned milk with 2 volumes of ordinary wheat bran*. Mix until all moisture has been distributed equally in the bran.

* wheat bran is available at most feed stores.

B. Coffee Grounds - Dry Milk Method

Disperse 1 teaspoon of powdered milk in one cup of wet coffee grounds.

The bran-milk mix is an excellent medium, producing better results than the standard medium described in On the Fly. Coffee grounds and milk is a poorer quality medium, but gives consistent results.

Paul D. Merrick

Webster College
January 23, 1967

Put the entire mix in a wide-mouth, one gallon jar and disperse from 1500 to 2000 eggs in it. Cover the jar with a paper towel and secure it with a rubber band. On each of the first three days after innoculation, shake the mixture once every twenty-four hours. If too many eggs are used, however, pupae and the resulting flies will be small. On the other hand, too few eggs in this quantity of mix may result in no pupae at all.

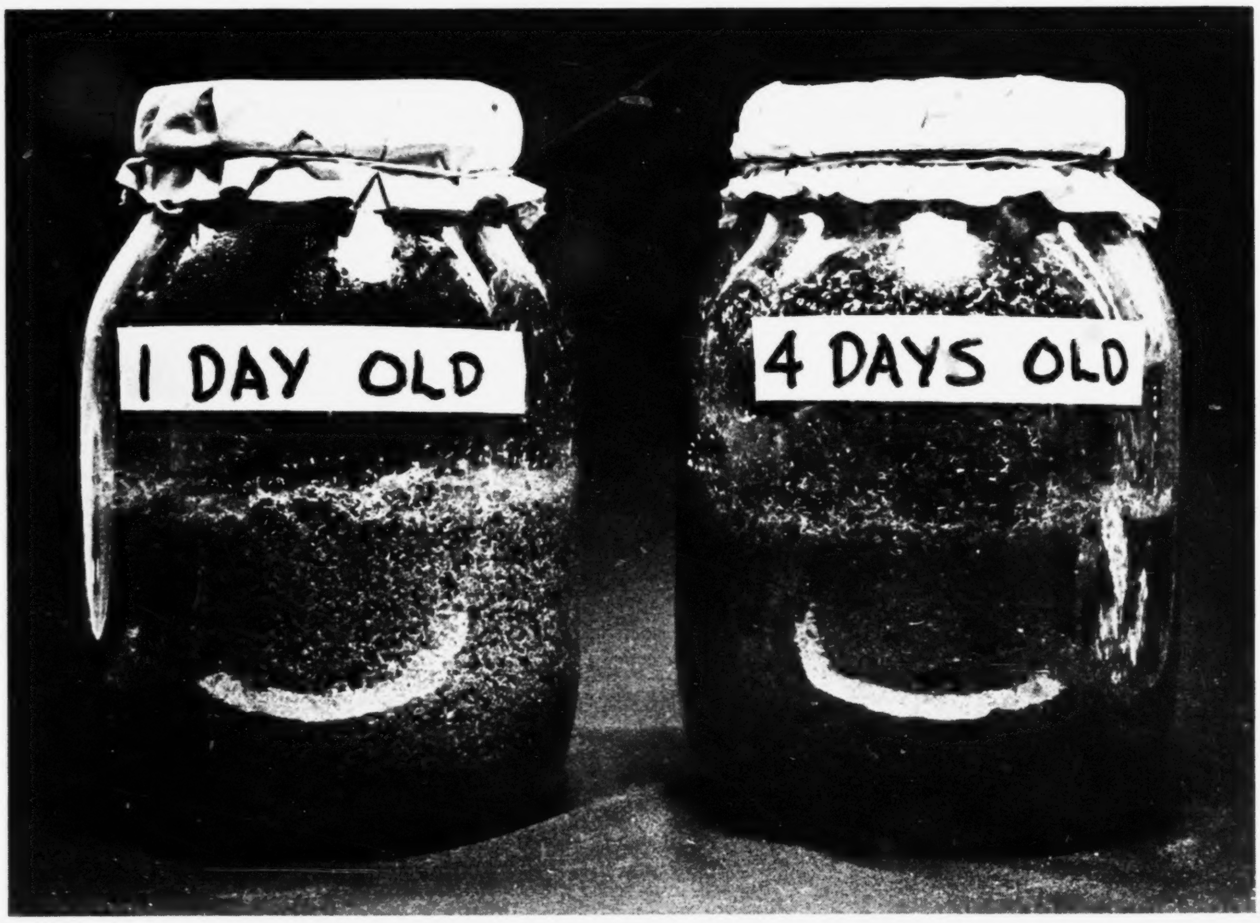

Figure 7

One "batch" of larval medium is sufficient to fill the one gallon jar to about the two-thirds level. As time goes on, however, the larval medium undergoes considerable changes, partly because of the activity of the growing larvae, and partly because of changes wrought in the medium by microbial life. The medium starts out with the sweet smell of newly-mown hay and progresses through a series of "strong" odors until it smells heavily of ammonia. Terminally, it takes on the odor of rich earth..... and, in fact, makes excellent humus-fertilizer for gardens.

As the medium changes chemically, it also changes physically. The volume "shrinks" noticeably; and, in the case of a successful culture, when a large number of pupae are formed, it becomes as level as a table top.

Subsequent discussions elaborate upon the use of variations of this technique on a smaller scale (pages 23& 25).

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THE PUPAL STAGE

Pupation starts about the fifth day after the eggs have been innoculated into the larval medium. By the seventh day very few, if any, maggots can be found in the medium. Maggots change quite rapidly into pupae, once the process has started. If a pupating culture is "dissected," the maggots can be observed as they pupate. (See The Chicken and the Egg, page 19).

Generally, most of the pupae have matured by the seventh or eighth day and can be separated from the larval medium. "Picking" pupae is an activity that the children in our trial groups enjoyed thoroughly. In a sense, I suppose, it's like an Easter egg hunt where everyone finds dozens of "eggs".

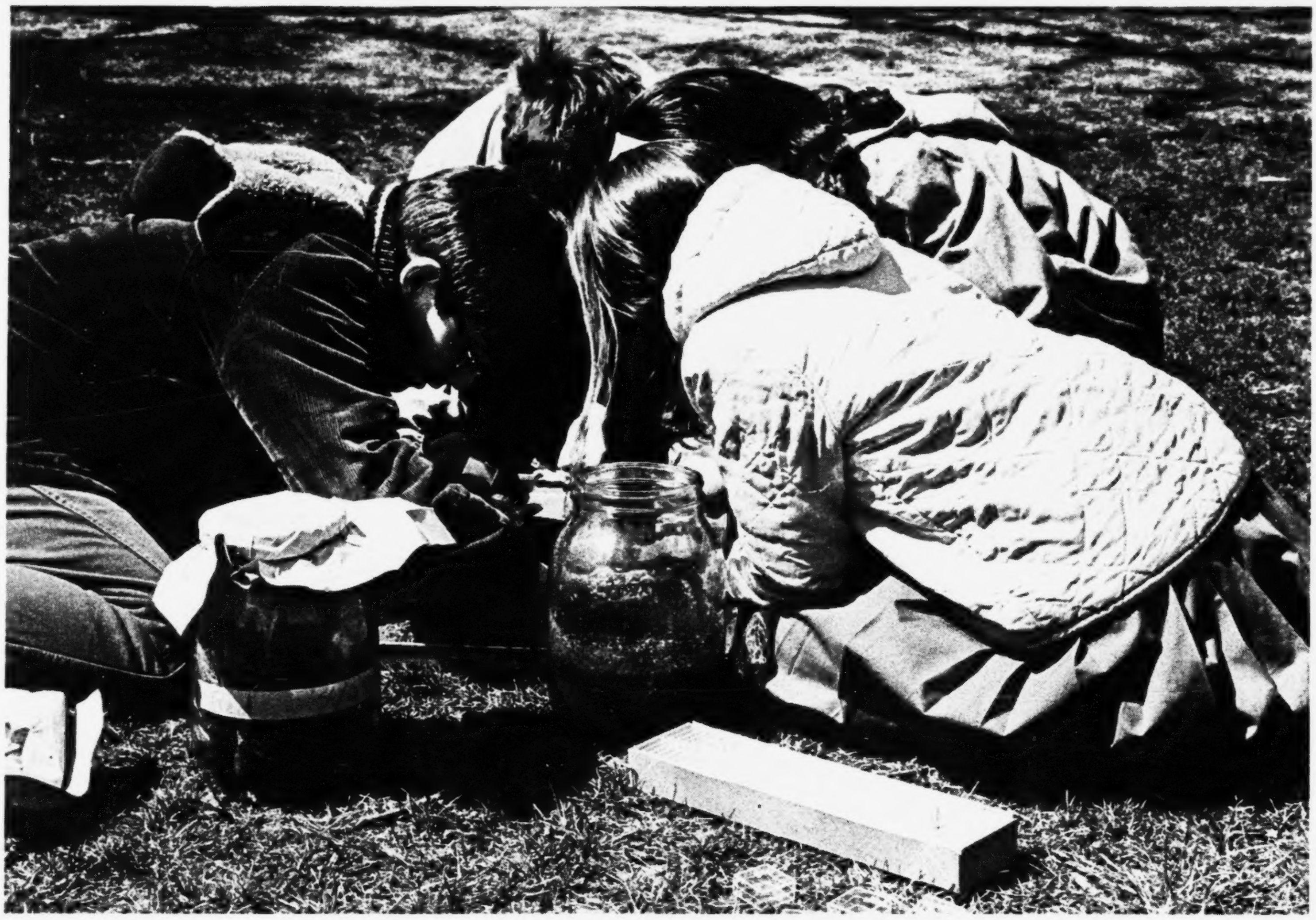

Figure 8

This particular picture was taken of fifth grade children working in our "phenomenological genetics" class. The children have poured the larval medium into a large tray and are picking out the pupae with tweezers. They are then isolating single pupae in small plastic pill boxes. The flies emerging from these pupae will have green eyes (red eyes are normal). When the flies emerge, they will be classified according to sex and crossed with another strain. For the children in the picture, this is the fourth pupae-picking party they have attended.

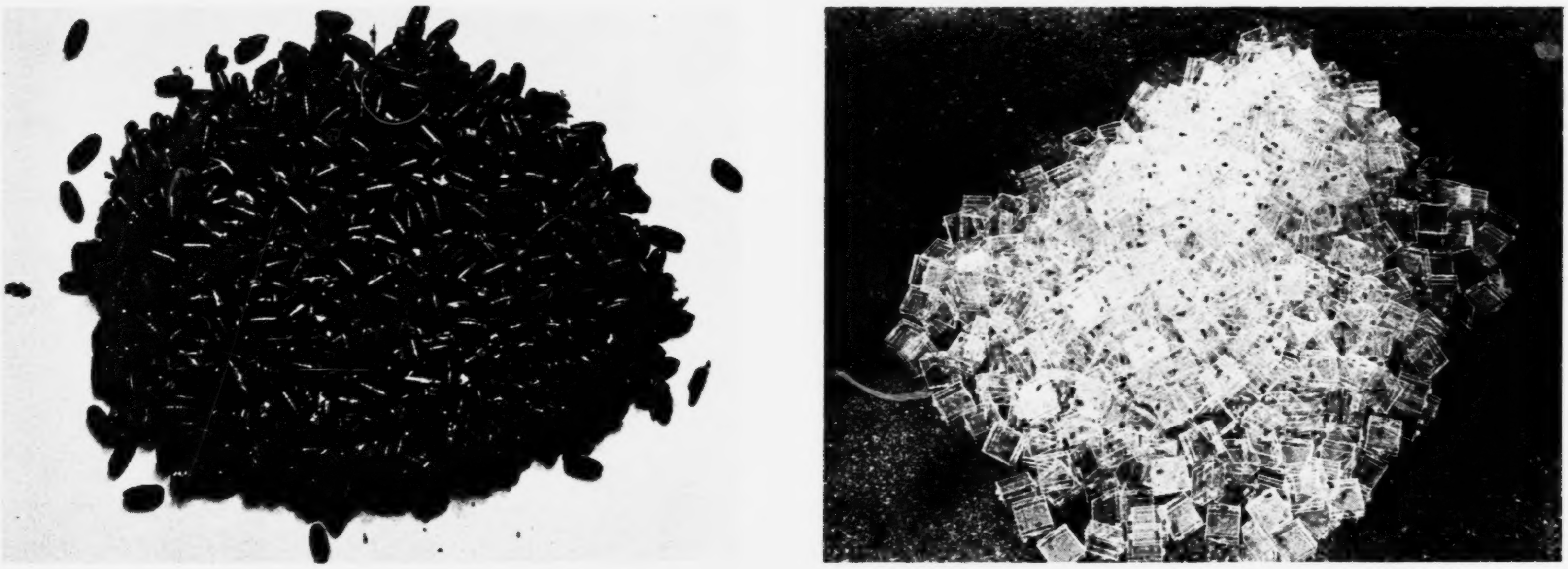

Figure 9

The picture on the left shows pupae harvested from a half-gallon of larval medium. When all 683 pupae are isolated singly in plastic pill boxes, the pile is imposing. Subsequently, over 625 of these pupae produced flies, enough for twenty individual cultures.

It is virtually impossible to predict when a fly will emerge from a given pupa. Once flies have started to emerge from a batch of pupae, however, a little vigilance will repay the observer. If pupae are spread out under a dissecting microscope, it is often possible to see a fly-to-be moving inside the pupal case. Many times the fly's movements will cause the pupa to display "Mexican jumping bean" antics. If you stick with it, you will see emerging flies "flip" their pupal lids and emerge as adults. Children never seem to tire of watching new flies being "born," and shouts of glee always signal the arrival of new "children".

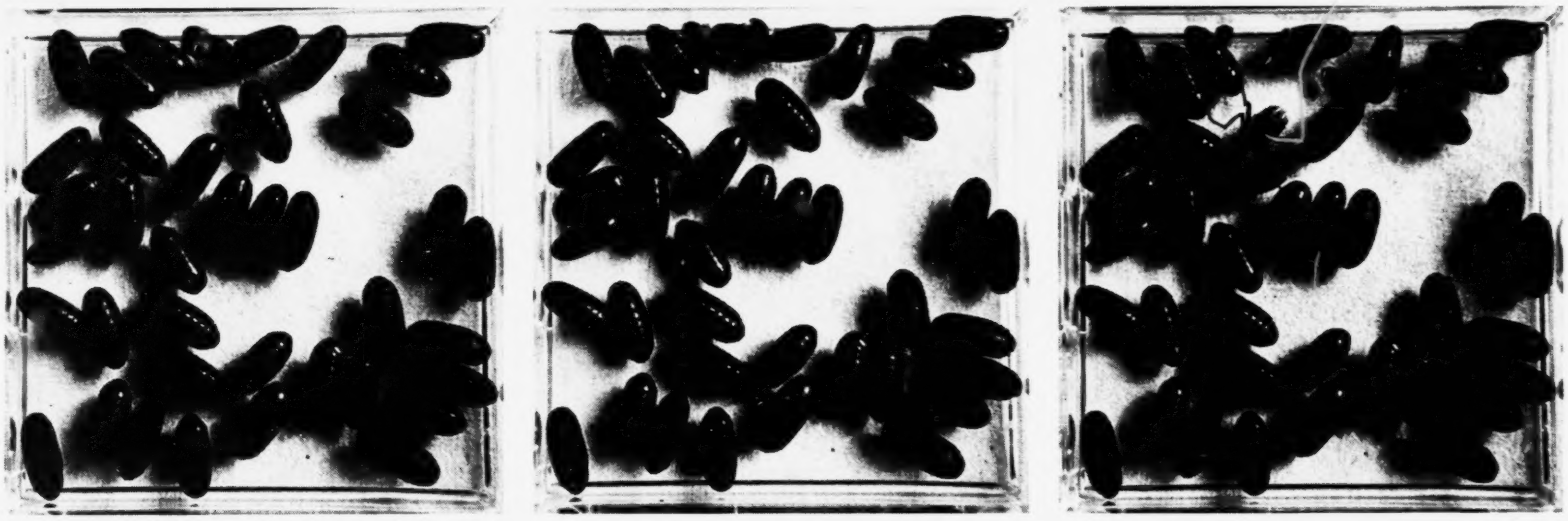

Figure 10

A young fly emerges from its pupal case quickly. Usually, only one or two minutes is required. Occasionally, however, one gets stuck and labors for a considerably longer period of time before it succeeds in freeing itself.

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Figure 11

Good to the last pupa.

Figure 12

Gold is where you find it.

THE ADULT STAGE

Adult flies emerge from the pupal stage approximately six days after pupation and ten or eleven days after the eggs are innoculated into the larval medium. Appearing incomplete and washed out following emergence, they crawl about in a manner more like a wingless bug than a fly. Actually, they are fully grown; but their wings appear as stubs, and their bodies are rubbery and light-colored. In a short period of time, they "inflate" their wings and a rigid exoskeleton forms giving them their characteristic gray-black appearance.

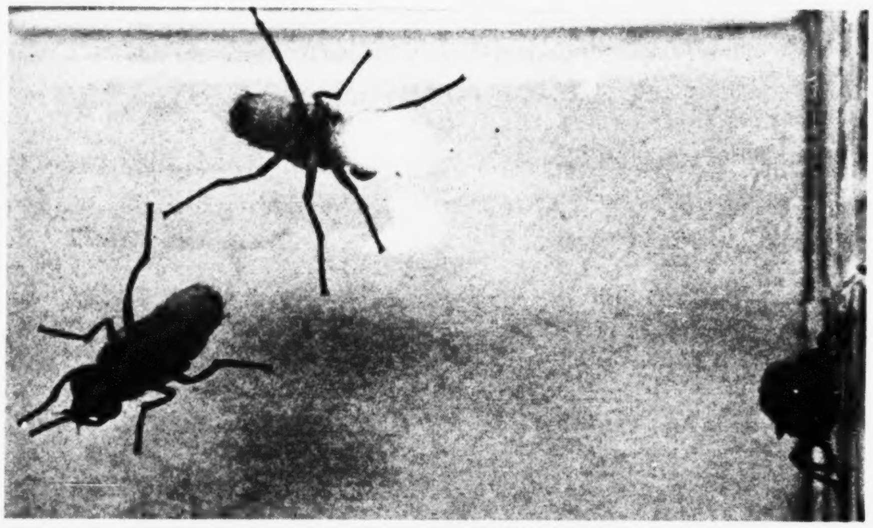

Figure 13

Newly-emerged adults

It is difficult to determine the sex of newly-emerged adults. In an hour or two, however, distinct sex differences show up (Figure 14).

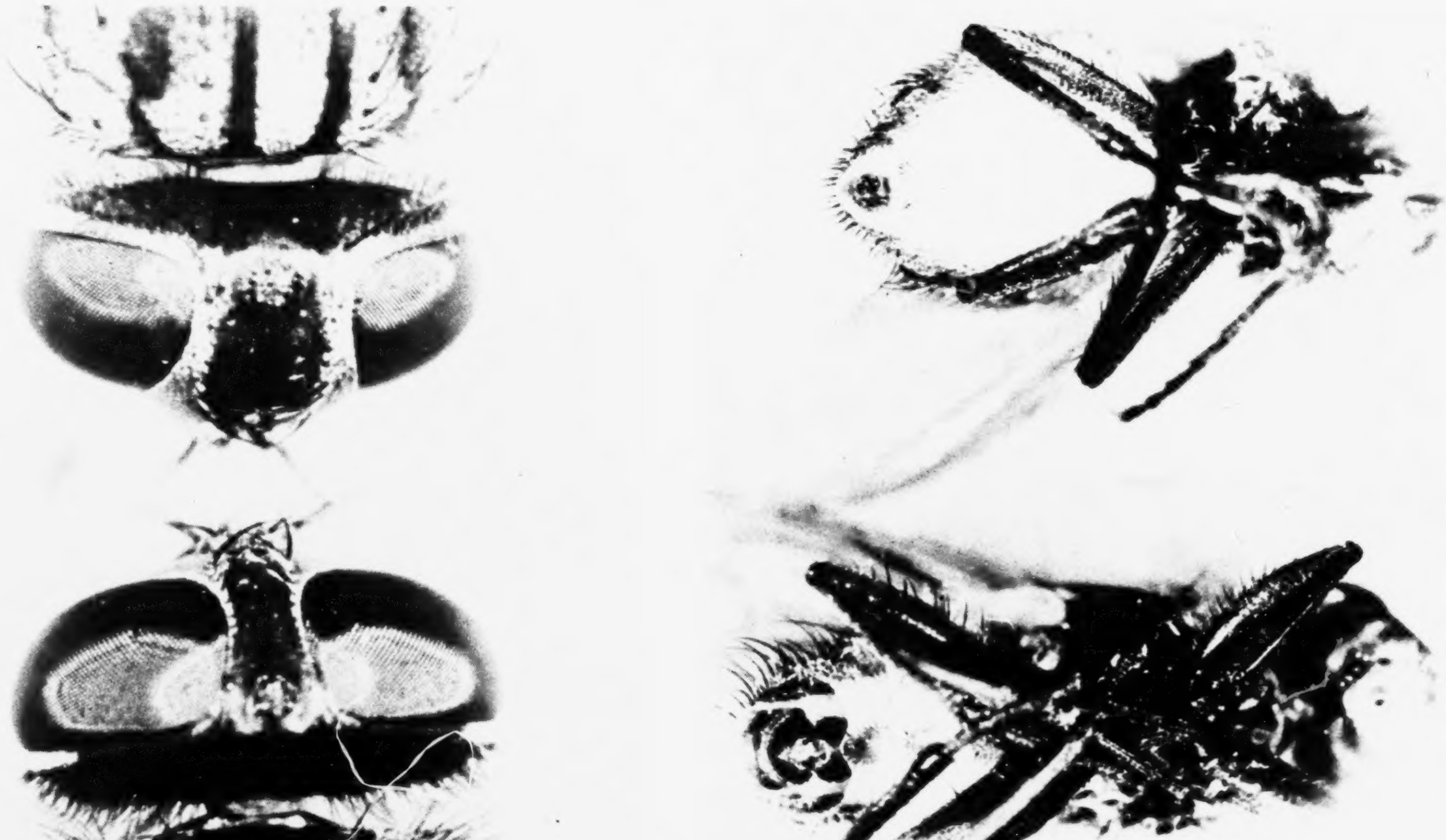

Figure 14

One really doesn't have to know which is which, because the flies can be divided into two distinct groups if separation of the sexes is desired. Since even unfertilized females will lay eggs, positive sex identification can be made when the abdomens of females become swollen. It is often said, however, that female house flies are "broadminded".

In our laboratory female flies appear to be much hardier than males and, on the average, outlive them. (Even in fly society the male is short-changed..... er, short-lived.) Not only is the female house fly hardier than the male; but she is strictly monogamous, breeding only once during her lifetime. The male fly, on the other hand, is considerably less faithful.

Under classroom conditions it is not advisable to handle large numbers of flies outside their cages. Individual flies can be trapped easily with a pill bottle and removed from the cage for study. The task can be made even simpler by putting the cage in a refrigerator for a few minutes. Low temperatures slow the flies down so that they can be caught rather easily. For longer periods of anesthetization, exposure to carbon dioxide gas will do the trick (Figure 15).

One convenient method of anesthetizing flies makes use of "dry ice". The operation can be carried out right in the cage. At room temperatures, dry ice is rapidly converted into carbon dioxide gas.

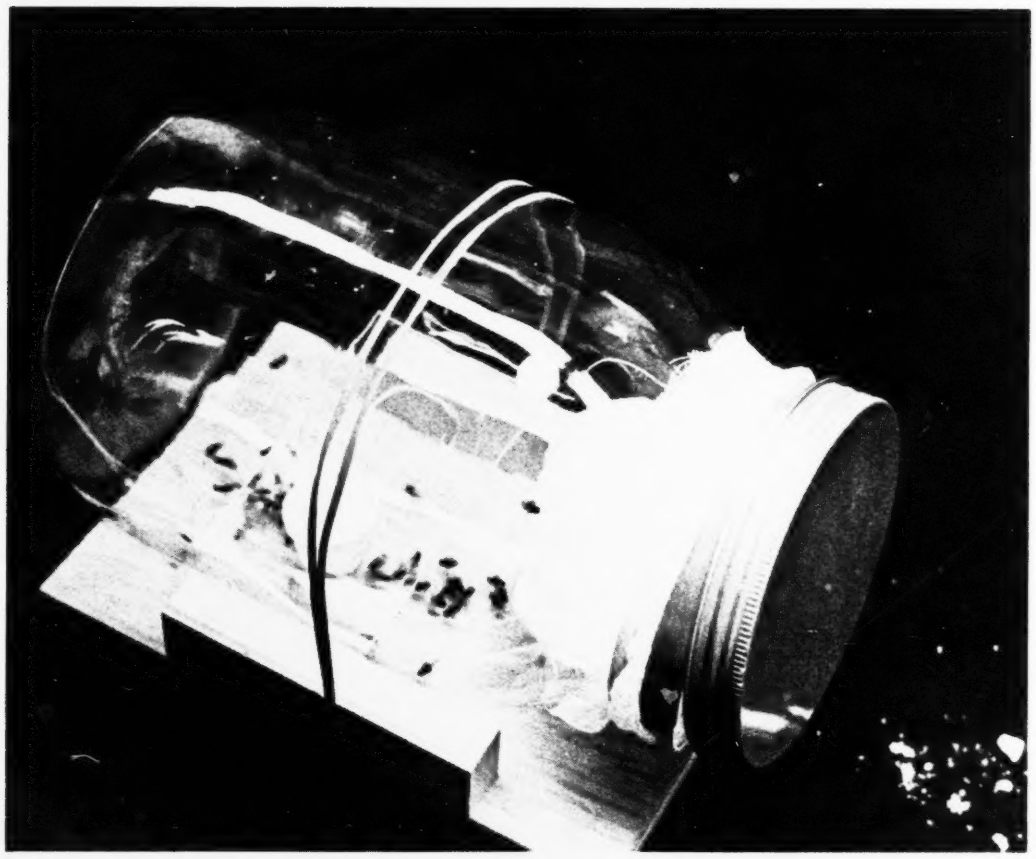

Figure 15

A. Extend the sleeve. Put a small piece of dry ice on it, about half-way down its length. Tuck the sleeve and dry ice into the mouth of the jar.

B. Put a lid "loosely" over the mouth of the jar. Keep it in position until one minute after the last fly is "knocked down".

Adult flies can be studied with a microscope or hand lens for fine details (and the house fly has much to offer here). If they are dead or anesthetized, they can be examined in the open. A piece of masking tape (or better yet fly-paper) placed on the bottom of a pill box, immobilizes live flies sufficiently to permit observation. An anesthetized fly can be fixed to the tape either upside down or rightside up.

Plastic pill boxes (obtainable from drugstores) are especially useful when working with house flies; for example, sex separation can be accomplished very easily by their use. After the pupae have been harvested, they can be isolated singly in pill boxes and their sex determined at leisure. The adult flies can then be released into cages according to the requirements of the situation. This technique is particularly useful in genetic studies where different strains of flies are being crossed.

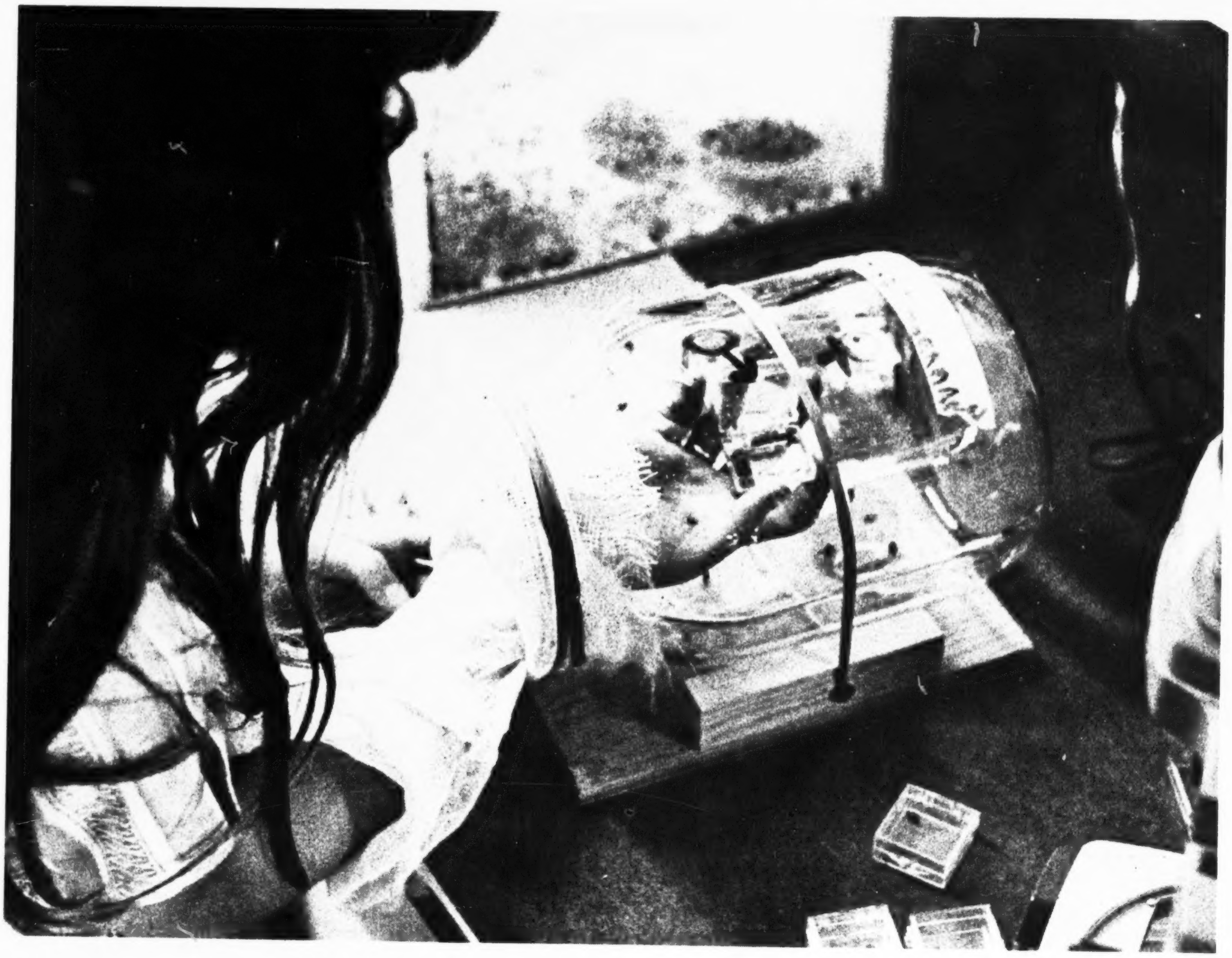

Figure 16

Separation of males and females is facilitated by putting single pupae in pill boxes and allowing the adult fly to emerge in isolation.

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OPENING MOVES

When we started the trial teaching of the house fly materials with children, we were interested in hearing and seeing their reactions when they saw pupae for the first time. We prepared some elaborate plates containing pupae, seeds, beads and stones. The idea was to present the children with sets of objects from the animal, vegetable and mineral worlds as well as some man-made objects. We had gone to some effort to select pupae which were ready to hatch. Those plates in which flies had already hatched before the class started were removed. Each youngster then had a plate with unhatched pupae on it..... but, hopefully, with some pupae ready to hatch into adults during the next few minutes.

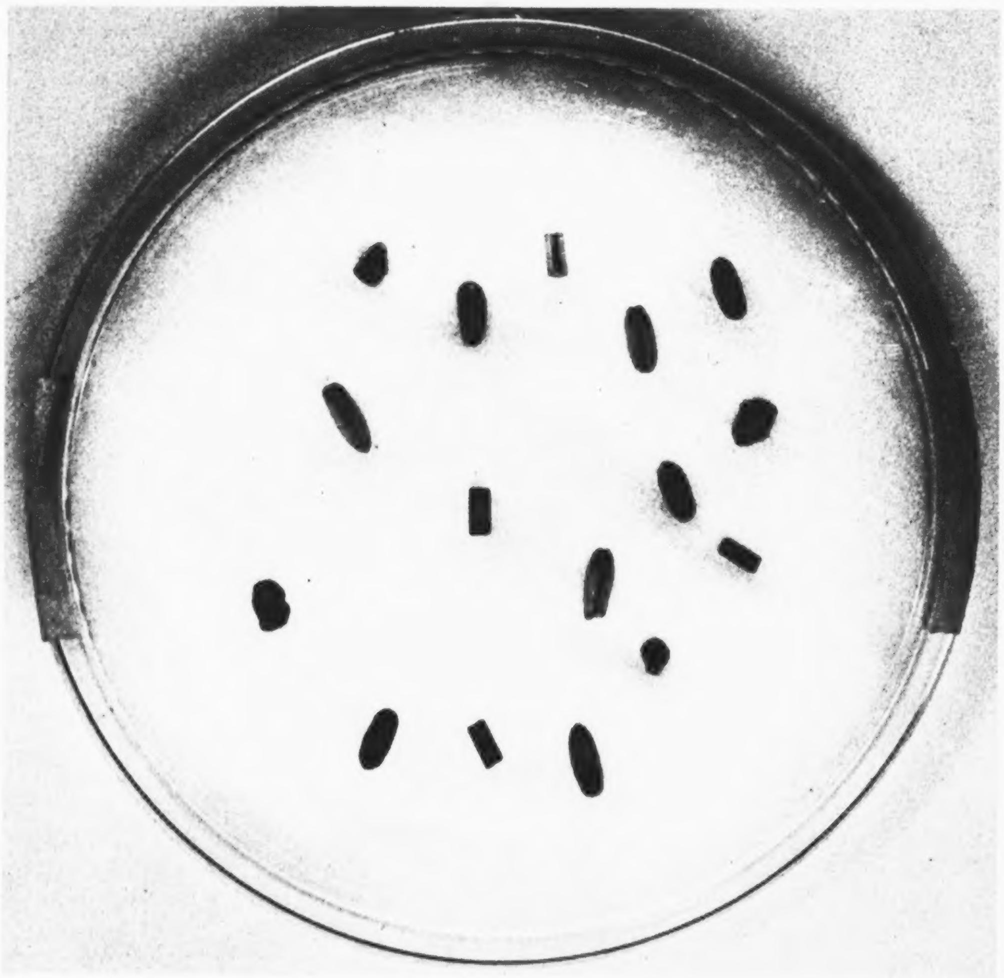

Figure 17

The various objects were positioned on the bottom of a plastic Petri plate and covered with a loose mass of cotton. The top was sealed in place with several bits of masking tape. In the plates shown here, there are four pupae, four grain seeds, four small stones, and some cylindrical beads of different colors.

All of the plates we used for the first lesson contained the four different classes of objects, although the pattern was varied from plate to plate. Three of the four sets contained nearly identical members, but the fourth set contained different representatives of the same class. For a while the discussion had all of the earmarks of a classification experience..... until someone shouted that a "bug" had appeared on his plate. Well, needless to say, this launched us off into the study of house flies. Before long, other "cooperative" pupae produced new adults. At this point the classification lesson belonged to the ages.

THE CASE OF THE FLEXIBLE FLY

Mrs. Helen Eckelkamp, a Webster College student, was faced with a problem resulting directly from her experiences with house flies. She had taken house fly materials home from the college laboratory for some "time" observations. Among these things was a plastic Petri plate containing several hundred pupae ready to hatch into adult flies. One of her children got very excited when the young flies started to emerge from their pupal cases. He insisted upon taking some of the pupae to school the next day to show to his class. Knowing that pupae in a Petri plate could create havoc if the children removed the cover after the flies had emerged, Mrs. Eckelkamp was confronted with the problem of telling her youngster that such a venture was impossible or devising a system which would allow the children to observe flies being "born" without the associated problem of "free flies." She chose the latter course of action and invented the system.

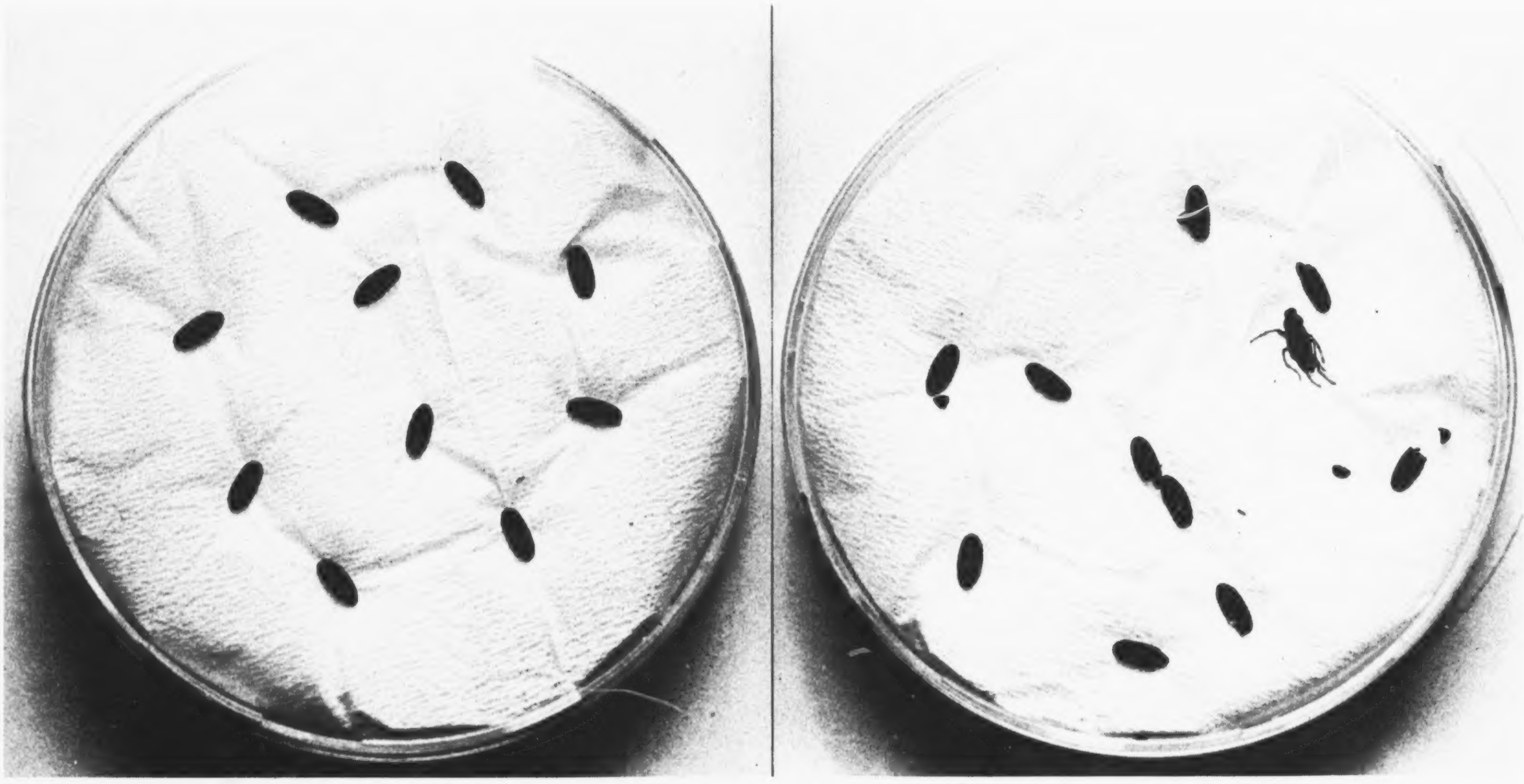

Figure 18

The pupae are placed in the bottom of a plastic Petri plate and covered with a piece of facial tissue. The rest of the space is filled with a loose mass of cotton, and the top of the dish is fixed into position with masking tape. When the flies emerge, they tend to move about in the "fissures" created by folds in the tissue. The flies often move about on the surface of the tissue for several hours.

When a fly emerges from a pupa which is lodged deep inside a manure pile, it has problems. Somehow it must make its way a considerable distance through a wet, heavy mass. The behavior of a newly-emerged house fly when trapped in the tight quarters between the plastic surface and the facial tissue gives some clues as to how it accomplishes this migration. A young fly is amazingly resilient, being able to squirm and twist in a manner more reminiscent of a worm than of an insect. It can inflate and deflate its head at will, and its "swimming" motion as it moves is remarkable. One can look at thousands of newly-emerged flies and never be aware of the "flexible fly." Helen Eckelkamp's technique, born out of real need, makes it possible for the fly to display this seemingly "unfly-like" behavior for all to see.

THE CHICKEN AND THE EGG

Mary Hodge, an exchange teacher from Leicestershire, England, who teaches the first grade children in the Webster College Experimental School, asked one day if there was something the youngsters in her class could do with flies. We decided to dissect a larval culture in the pupation phase and present the children with maggots and pupae in the same container. I had tried this previously with the children of a friend and had some idea of what to expect in the way of a reaction by the first graders.

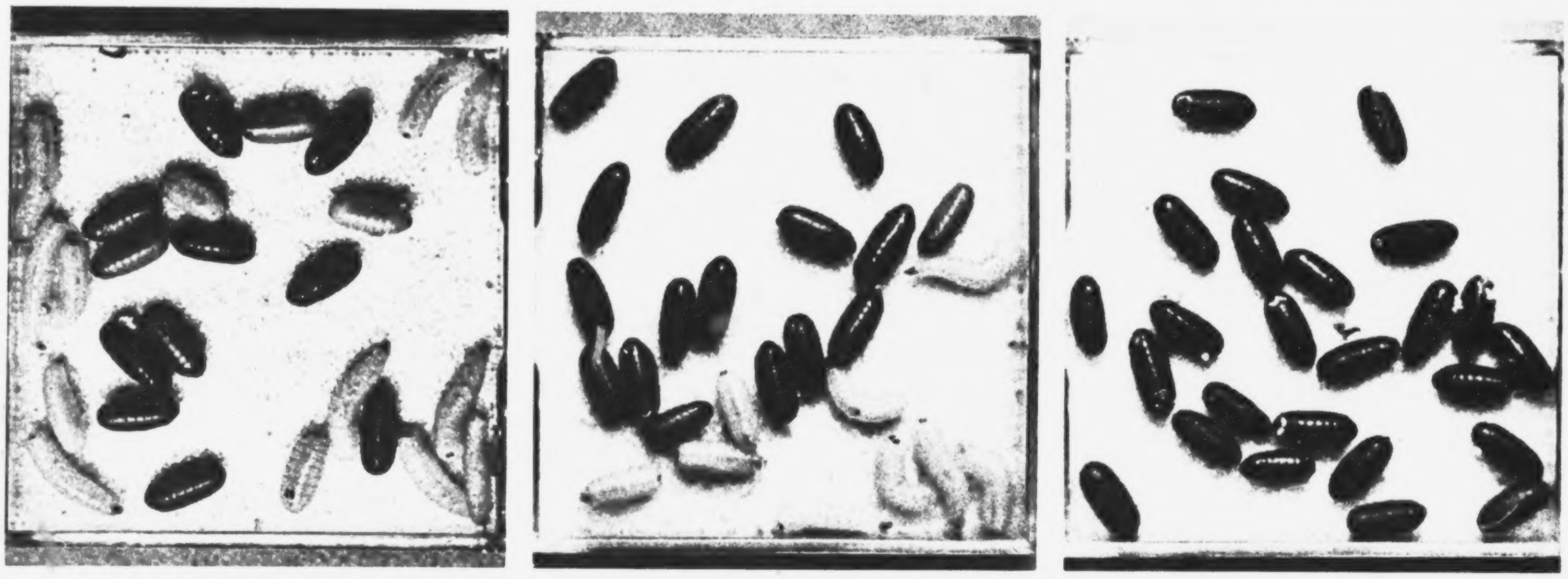

Figure 19

Mature maggots readily pupate in the open air, producing pupae which are indistinguishable from those which form within the larval medium itself.

At first the pupal covering is the color of the maggot. With the passage of time, however, the pupal case darkens, progressing from yellow through various shades of red. Mature pupae are a deep reddish-brown. The picture sequence consumed sixteen hours.

The first grade children failed to associate, or recognize, the decrease in number of larvae with an increase in the number of pupae as the day progressed. They were firmly convinced that the pupae were "eggs" and the worms (larvae) had hatched from them. The next morning when they returned to school all of the larvae had pupated. They adamantly accused Mary Hodge of replacing the worms with "eggs." In a day or two the children lost interest in the "lifeless" pupae. Then six days later one of the children discovered live flies. Persistent observation was rewarded when the children actually saw a fly emerge from a pupa.

I doubt that the observation of the fly emerging from the pupal case dispelled the idea that the worms had also emerged from the pupal "eggs." The youngsters in our fourth and fifth grade trial classes had seen flies emerge from pupae before they were confronted with the plate containing both pupae and pupating larvae. MOST OF THE CHILDREN WERE CONVINCED THE PUPAL "EGGS" HATCHED INTO WORMS. Someone asked where the pupae came from; another answered that they were "eggs" laid by the flies. To these comments another student remarked, "That's absurd; flies could never lay eggs that large!"

We have tried this little gambit with many adults. Almost all have responded in much the same manner as the children; the pupae are eggs, and the worms have hatched from them. This is not too surprising. Pupae have the structural characteristics of the eggs most of us are familiar with, i.e. shape, dry brittle shell, etc.

Once the children in our trial classes found out the "things" on the classification plates produced flies, they looked up fly in the encyclopedia and found pictures of the egg, larva, pupa, and adult stages. Yet none of this information seemed to be relevant when it came to deciding which came first - the larva or the pupa. Some of these same children are presently working in our laboratory studying "phenomenological" genetics. They talk about such things as pupation time, worry about late-emerging flies, and discuss avidly the details of maturation in newly-emerged flies. There is something to be said for experiences in depth. Many times what seems to us to be repetition is in fact the catalyst to understanding.

THE VIABILITY OF FLY EGGS

No facet of house fly husbandry is more exciting to children than the first time they find fly eggs in their cultures. Flies really do lay eggs; they can be seen with the unaided eye, counted, and hatched into larvae with a minimum of effort and apparatus. Many times there will be tiny larvae, which have already hatched, mixed in with the eggs. Hand lenses and low power microscopes (10x to 50x) are the order of the day. Magnifying systems above 75x are too powerful for "good" viewing.

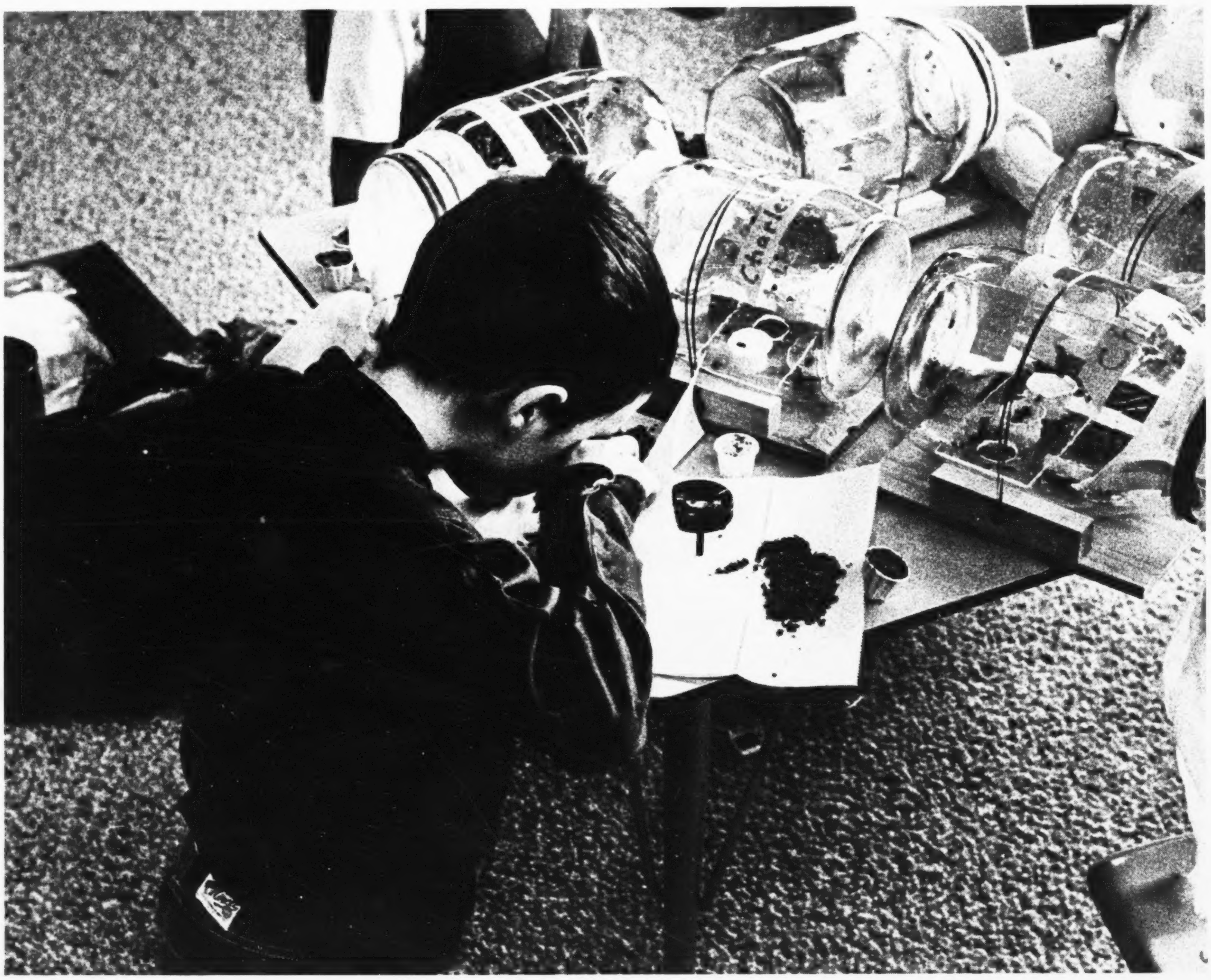

Figure 20

Eureka! They're fly eggs.

Fly eggs will hatch into tiny larvae on an open surface, provided there is sufficient moisture. Figure 22 shows a technique for hatching fly eggs on a small square of moist blotter material in a plastic pill box.

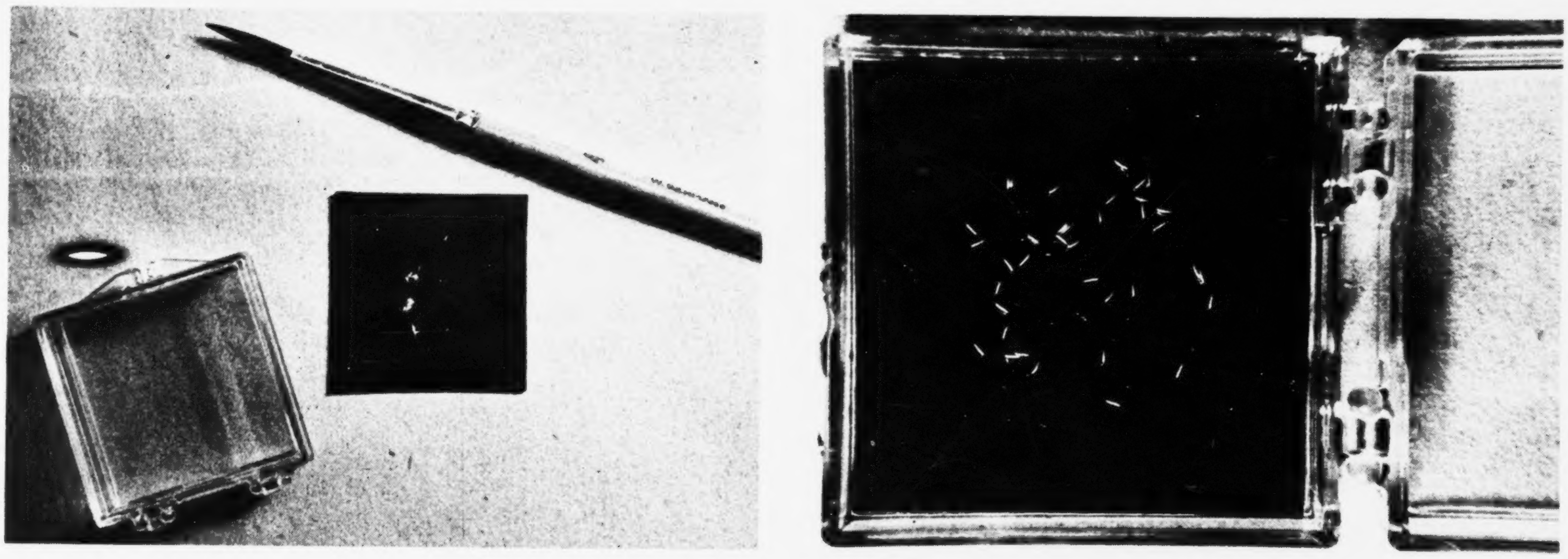

Figure 21

The tools of the trade: blotter paper, pill box, eggs, and a water color brush. The eggs are spread out on the moistened blotter paper. The pill box should be kept closed to prevent drying out. The eggs usually begin to hatch in six or eight hours, but may take longer if the room temperature is too low.

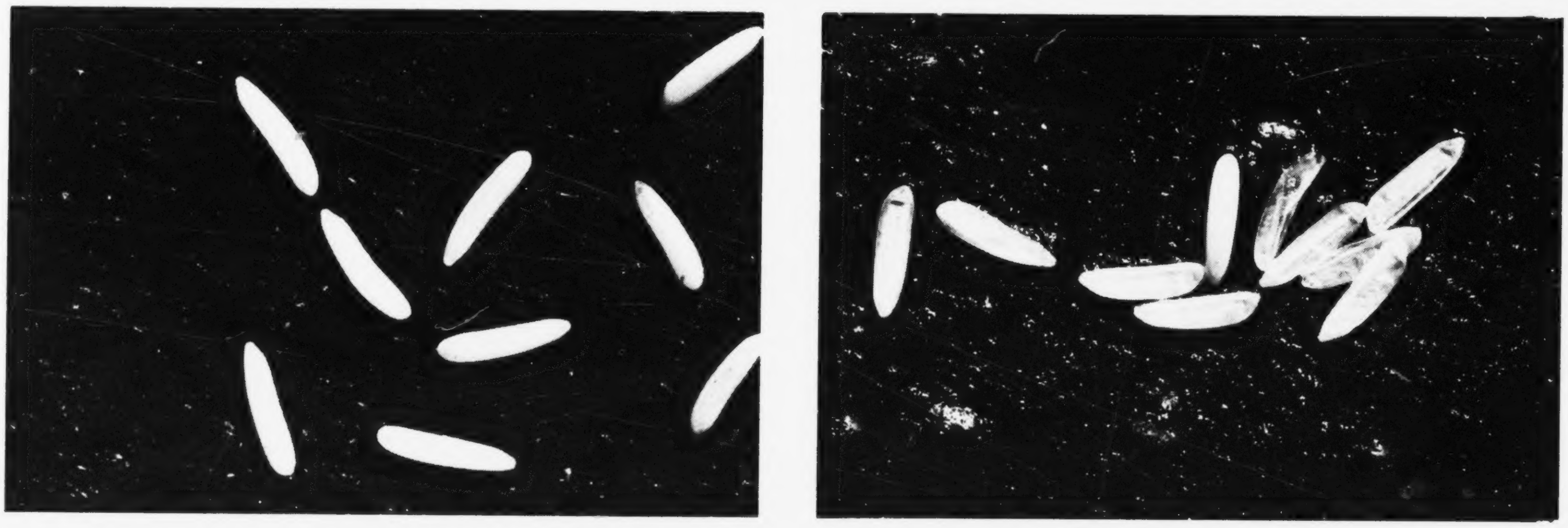

Figure 22

Fresh fly eggs are rigid, sausage-like objects. After the larvae emerge from the eggs, they leave crumpled egg sacs behind. All but one of the eggs in the right hand picture was viable.

Freshly harvested eggs should be examined with a hand lens to be sure that they have not dried out. A dried out fly egg is usually collapsed in the center, while an empty egg sac is completely flattened.

The egg-viability test can be correlated nicely with classroom mathematics. For every larvae there is an empty egg sac (one to one correspondence). The number of eggs tested can be related to the egg sacs, larvae or unhatched eggs (percent, fractions, and ratio and proportion).

PUPAE ON PARADE

When fly eggs are innoculated into a large quantity of larval medium (page 9) the majority of the maggots pupate in a central "cone" about an inch below the surface and a considerable distance from the walls of the jar. One seldom sees the pupation process in this system. Mature maggots do, however, tend to crawl up the sides of the jar just before the onset of pupation. If a layer of sand (about one inch deep) is poured over the surface of the medium just before pupation, many maggots will come to the surface and pupate.

Stauffer Chemical Company of Palo Alto, California, developed a clever system for harvesting pupae, cutting many man hours from the operation. A mass of larval medium is "basketed" in a piece of plastic wrap, and the bag-like object is placed in a cylindrical ice cream carton and covered with cloth or paper toweling. In four or five days, the fat, mature maggots crawl upward on the inside of the plastic wrap, go over the top, and crawl down the outside of the wrap. Finally coming to rest on the floor of the ice cream carton, they pupate. The pupae are then easily harvested from the bottom of the carton.

A Webster College student, Dianne Dignam, devised an elegant variation of the Stauffer method.

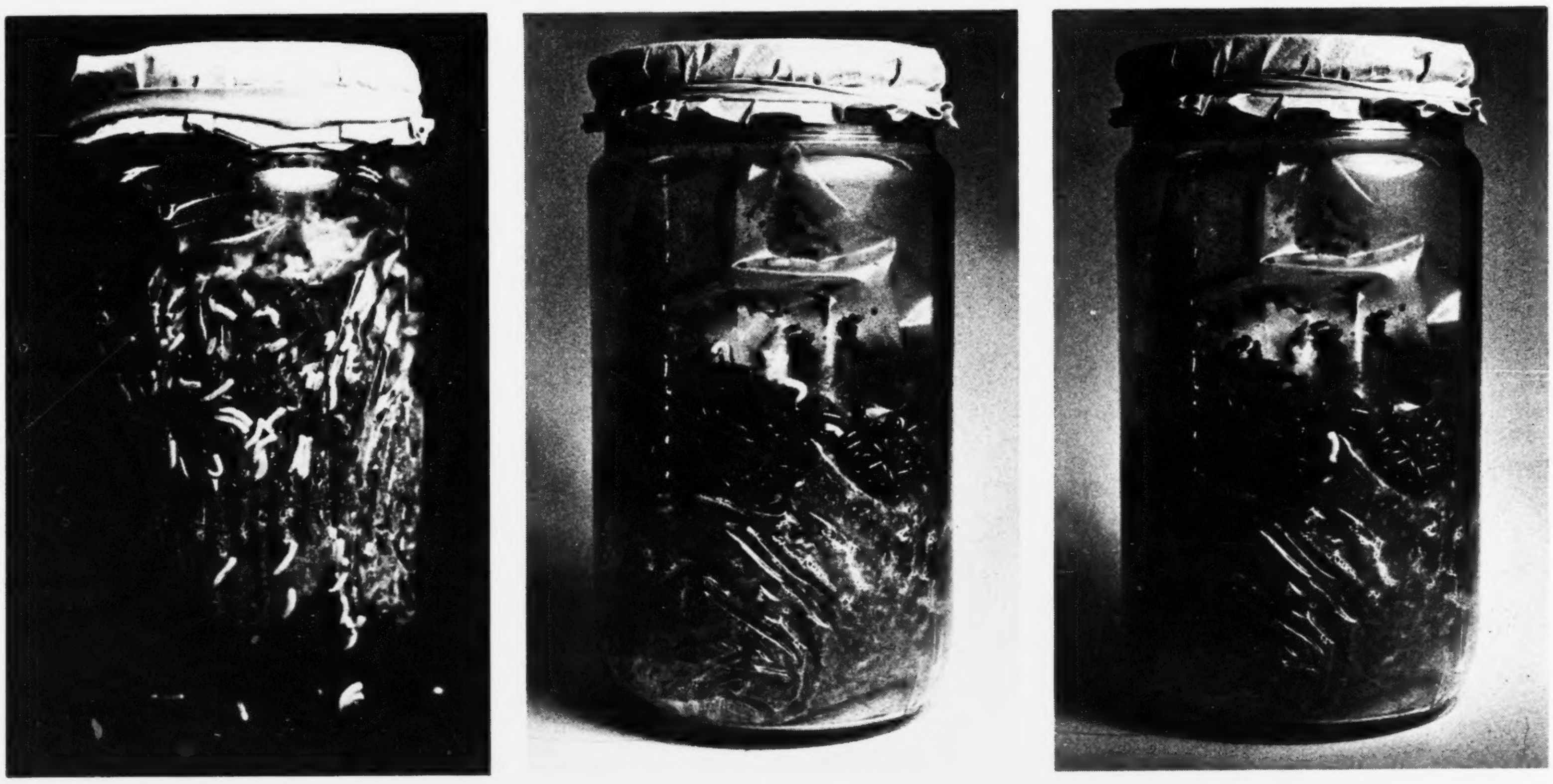

Figure 23

Larval medium is put into a plastic bag and innoculated with eggs. Then the bag and its contents are forced into a one quart, Mason-type jar. The plastic bag "seats" itself against the wall of the jar, providing a barrier to larval migration. As the larvae crawl down the outside of the plastic bag, they are trapped between the plastic and the wall of the jar. Eventually they pupate, leaving readily observable pockets of pupae.

This technique unveils an exciting biological process. We have prepared hundreds of these jar cultures in our laboratory, and we never fail to marvel at the "timed" behavior of the maggots. In fact, we became so enamored with this particular technique that it became the basis of a filmed classroom lesson, A Linear Look at the Fly.

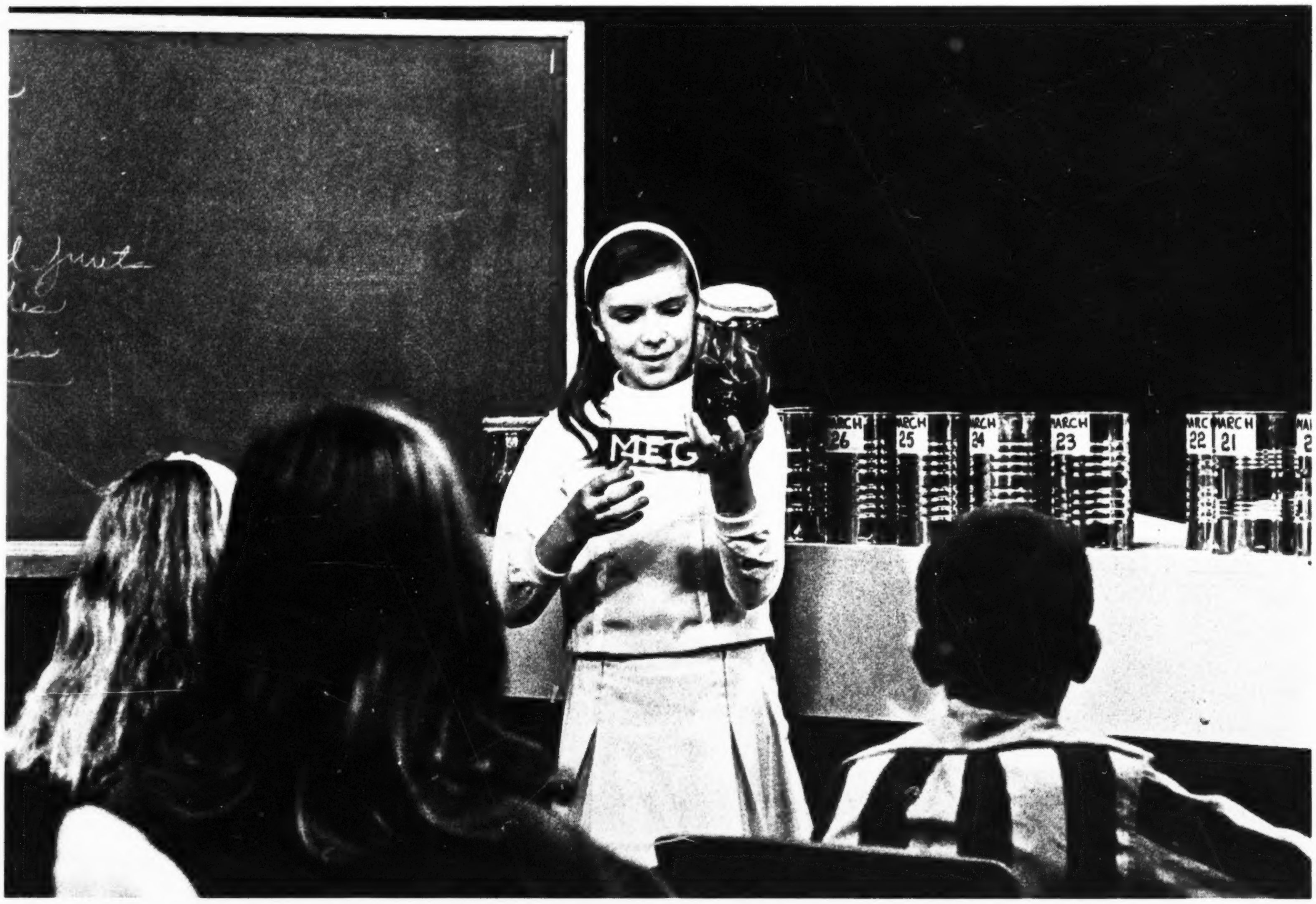

Figure 24

The classroom film, A Linear Look at the Fly, was made after completion of the trial teaching of the house fly materials. The life cycle of the fly, from egg to death, was portrayed in a linear sequence of fifteen larval medium cultures. Eggs were innoculated into the jars at twenty-hour intervals for fifteen consecutive days. The larval medium cultures were arranged in linear order according to age and covered with "dated" cans. The cans were removed by the children, exposing a particular stage in the developmental history of the house fly. The jar which Meg holds in her hand came from beneath the March 22 can. It contains mature pupae lodged between the glass jar and the plastic bag. The jar behind Meg's right shoulder was innoculated with fly eggs on the morning of the filming. Specific questions were asked by the teacher to stimulate discussion by the children, and each can was removed selectively as a result of this interaction.

LARVAL CULTURE ON A SMALL SCALE

The culture of fly larvae on a large scale in the one gallon jars is an efficient method for maintaining stock fly colonies. However, it is impractical for use in the classroom. Where children are working individually or in small groups, the quantity of larval medium required and the disposal problem can grow to enormous proportions. In our trial classes, we employed the technique described in Pupae on Parade. Since that time, we have evolved an equally utilitarian method which uses a considerably smaller quantity of the larval mix and has the added advantage of excellent visibility of the developing larvae.

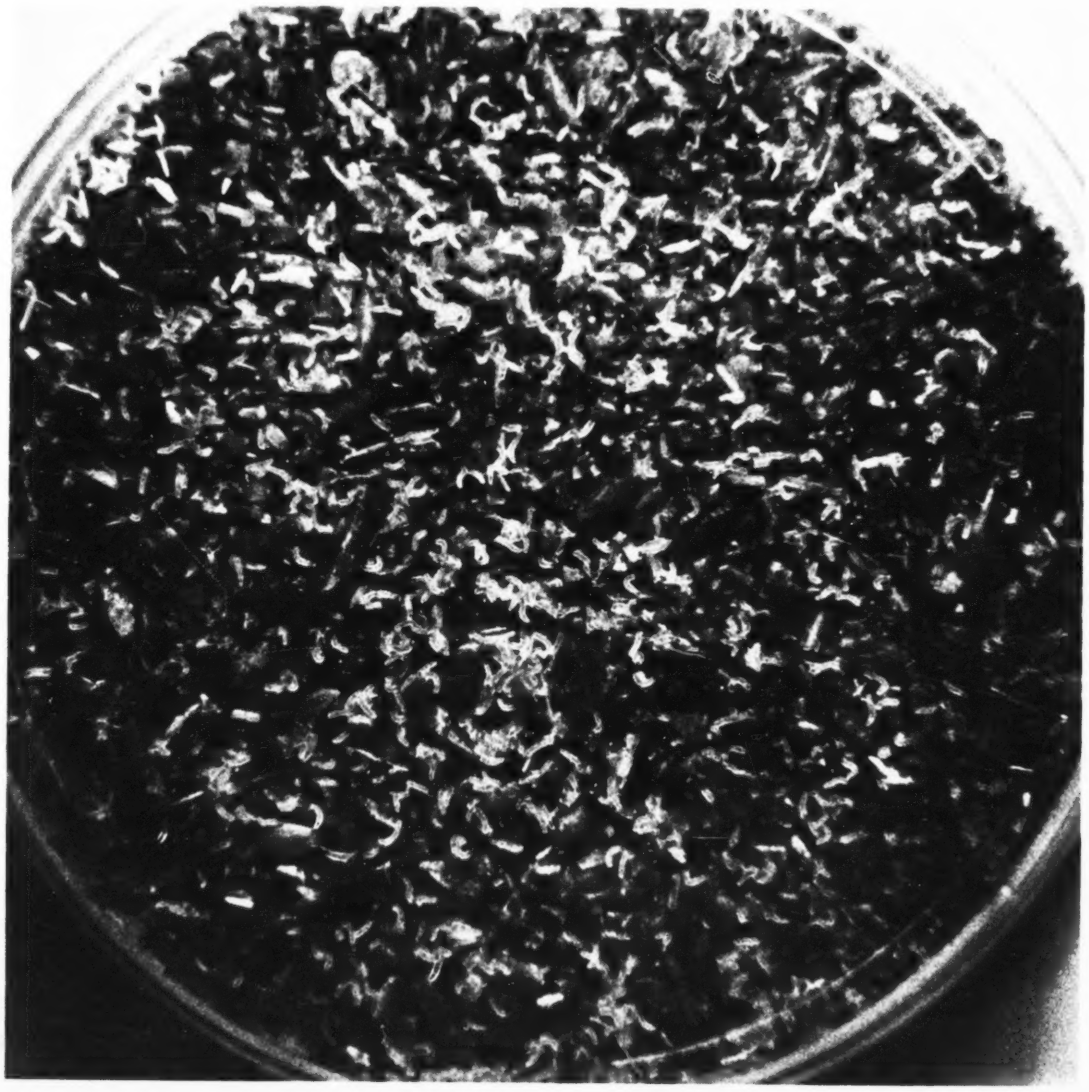

Figure 25

A deep, plastic Petri plate is filled LEVEL full with larval medium. If the dish is not full enough, it tends to dry out. If it is too full, a water seal sometimes forms and prevents air circulation. The plate above shows hundreds of the newly-hatched larvae moving about on the inner surface of the plate top.

Of all the methods we have tried, the Petri plate method is in many ways the most efficient. One seldom has a failure because of "molding" or drying out, and the method sometimes produces a hundred or more normal-sized pupae. The secret seems to be that the air inside the plate is never very fresh but, nonetheless, is fresh enough to allow the larvae to flourish. Molds, on the other hand, do very poorly in low quality air.

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The elaborate pupation process is visible only on occasions in the plate-culture method. The mature maggots usually migrate to the center of the medium to pupate, although they can be seen along the sides the day before the onset of pupation. Quite by chance one day, we agitated the center of the medium, trying to "scare" up enough maggots to take some photographs. We found a large number of mature maggots in the central "cone," brought them to the surface, and photographed them before they scurried back into the depths of the medium (Figure 26).

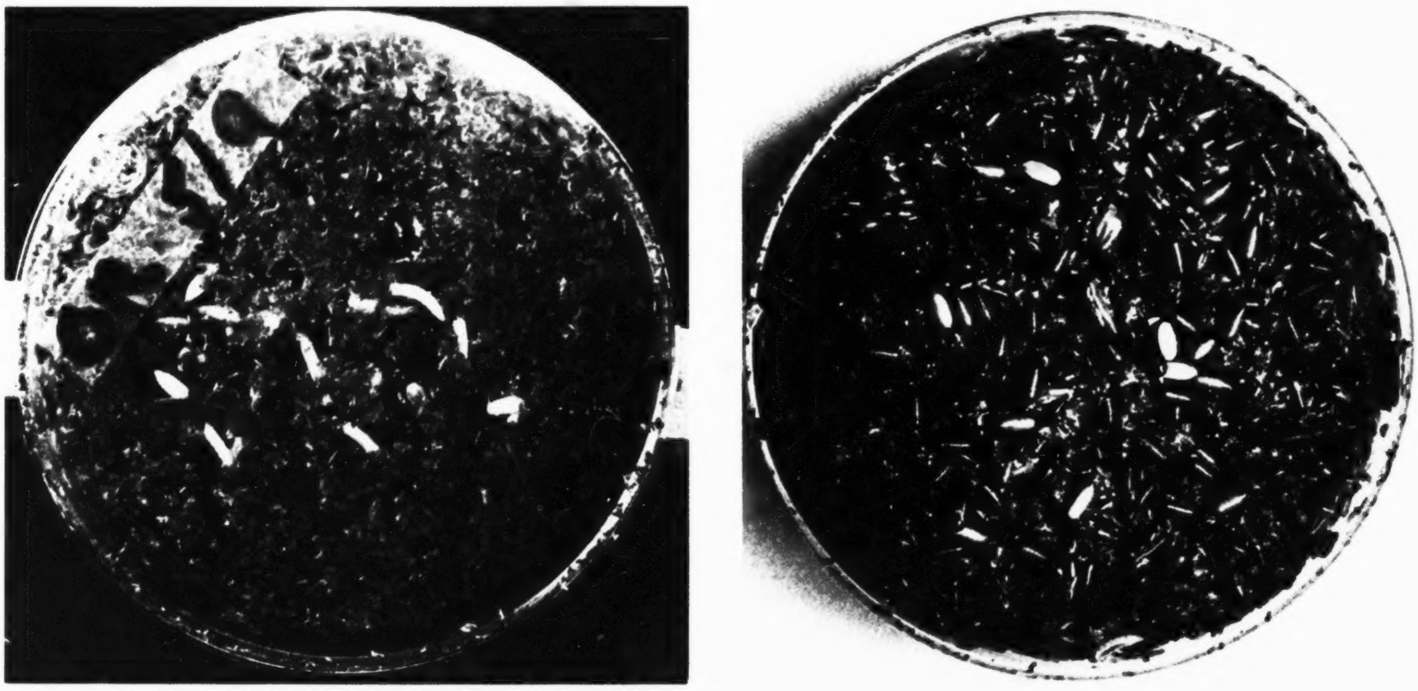

Figure 26

The larval medium was agitated just before the onset of pupation. The maggots shown on the surface came from the central "cone" (left). Later the majority of the maggots came to the surface to pupate. Of the 183 pupae harvested from this plate, over 100 were visible on the surface.

We recommend that 100 to 300 fly eggs be used in each plate of larval medium. This number seems to give the most consistent results. A sample run with 150 eggs produced 53 pupae. Of these, 44 produced adult flies. At other times we have recovered as few as 25 or even 20 pupae. Only 6 were found in one instance.

Fly larvae seem to have a "thing" about light; they avoid it whenever possible. If they are caught out in the open, as when one agitates the larval mix, they quickly scurry back into the depths of the medium. So agile are they at doing this that it is very difficult to get a good photograph of maggots in the medium. When a plate is set on a flat surface for a few moments, larvae accumulate on the side of the plate nearest the surface and disappear from the side exposed to the light. This behavior on the part of the larvae opens up an area of experimentation which has real possibilities. Do larvae respond to temperature? Gravity? If it comes to a choice between a hot, lighted surface and a cold, dark surface, which one will they choose? It is this aspect which makes the plate method attractive as a vehicle for individual experimentation.

APPENDIX I

CAGE SPECIFICATIONS

A one gallon jar will house sixty or seventy flies conveniently. We recommend, however, that the first time "around" the children do not attempt to house more than thirty in this cage.

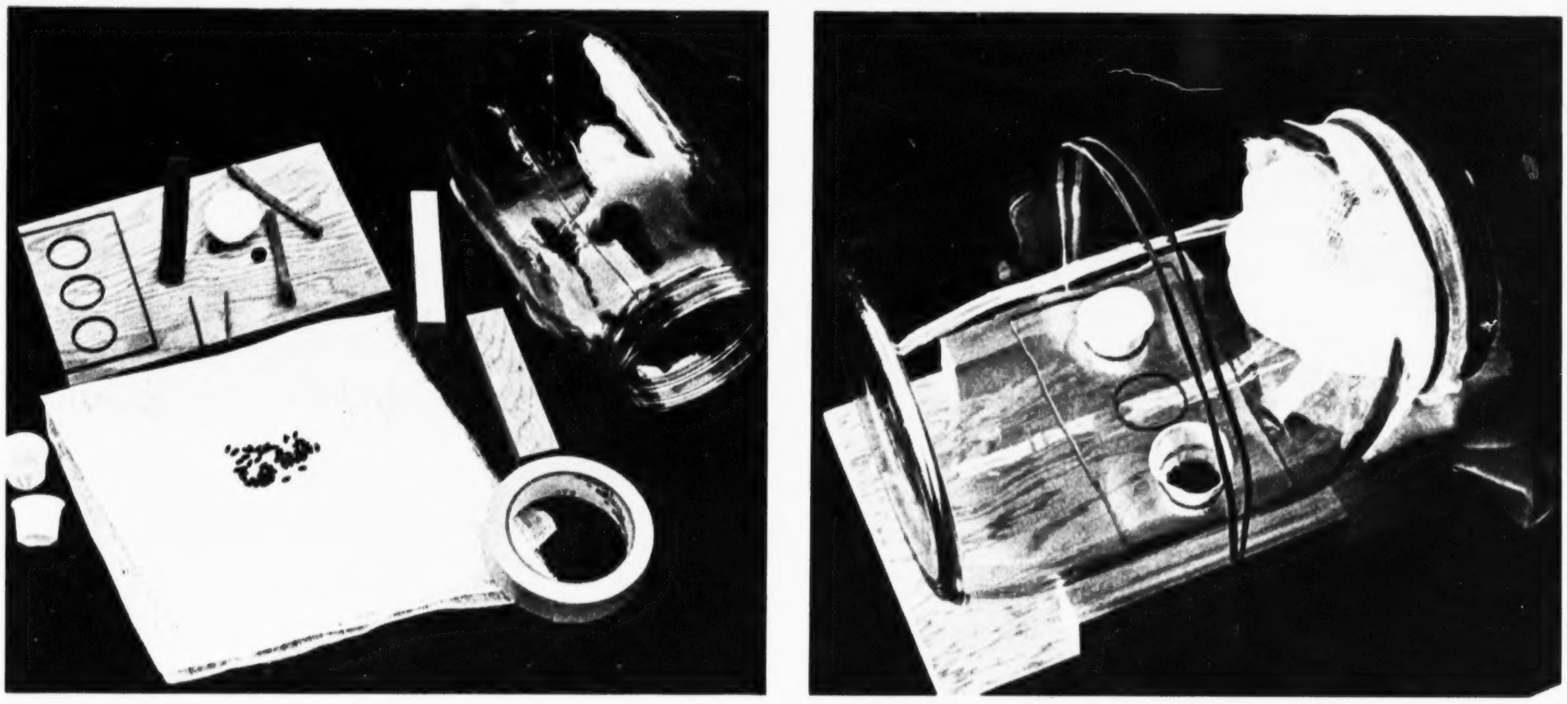

Figure 27

A. The unassembled parts include:
   1. A wide-mouth, one gallon jar
   2. A square of cotton gauze (24" x 24")
   3. Masking tape (1")
   4. Three wide rubber bands
   5. A plywood rectangle (5" x 7" x 3/8")
   6. Two wooden blocks (1" x 3/4" x 4")
   7. Some small, box nails
   8. Two thumbtacks

B. The gallon jar fits comfortably in the finished base. The jar is held in place by means of a rubber band stretched around it and anchored to thumbtacks fixed in the side blocks. The Plexiglas rack inside the jar has three one inch holes drilled into it to hold the souffle cups. Cardboard or wood could be substituted for the plastic. The sleeve is held in place by two rubber bands; the one around the neck holds the sleeve in place, and the wider one around the mouth prevents flies from becoming trapped between the gauze sleeve and the glass rim.

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APPENDIX II

STARTING A HOUSE FLY COLONY FROM SCRATCH

The weather in the St. Louis Area this spring has been unusually cool and damp, and few insects have poked their antennae out into the cold, hard world. We had intended to follow up our basic materials with some out-of-doors work for the fourth and fifth graders. The children were to have devised fly traps to capture adults and to obtain eggs from "wild" flies by a kind of reverse-Redi technique. However, the weather foiled us completely. We decided to do the next best thing and release several hundred flies in our laboratory and then try to catch them.

In the seventeenth century Francesco Redi, an Italian naturalist, performed a series of definitive experiments which became "milestones" in the history of science. Redi's experiments showed conclusively that life came only from pre-existing life, in contrast to the idea that life could arise spontaneously from non-living materials. Essentially, Redi put covered and uncovered samples of meat, etc. out in the open air for a few days; then he brought the samples back into his laboratory for observation. He consistently obtained maggots, then pupae, and finally adults from the uncovered samples. Samples from covered containers, on the other hand, seldom, if ever, yielded maggots, pupae, or flies. It is doubtful if Redi, himself, ever saw fly eggs.

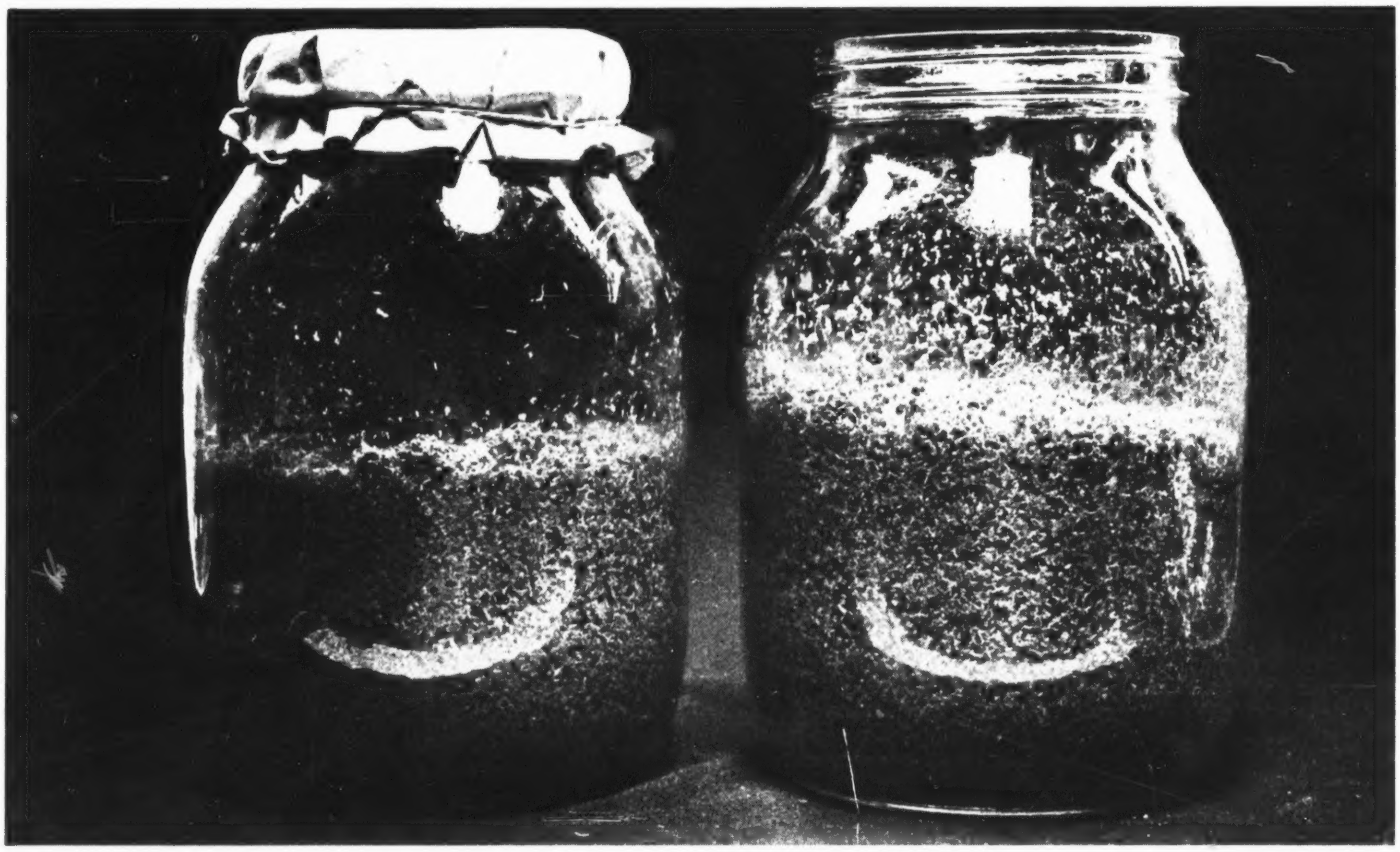

Figure 28

A jar of larval medium which is closed off at the top seldom yields maggots or pupae. One can, however, set an open jar of larval medium out-of-doors and entice "free" flies to deposit eggs in it. Of course, there is no guarantee that house flies will have preference, unless you place the jar in a spot where house flies are predominant.

Another method for starting a colony is to trap adult flies. This can, of course, be done with a fly swatter, provided you have confidence in the quantitative quality of your swing. A gentle tap, with luck, and the fly is only stunned. On the other hand, ever so slight an increase in pressure; and, instead of a fly, you have a mess.

We made a small modification on the basic cage and then went "hunting"..... in the laboratory, of course.

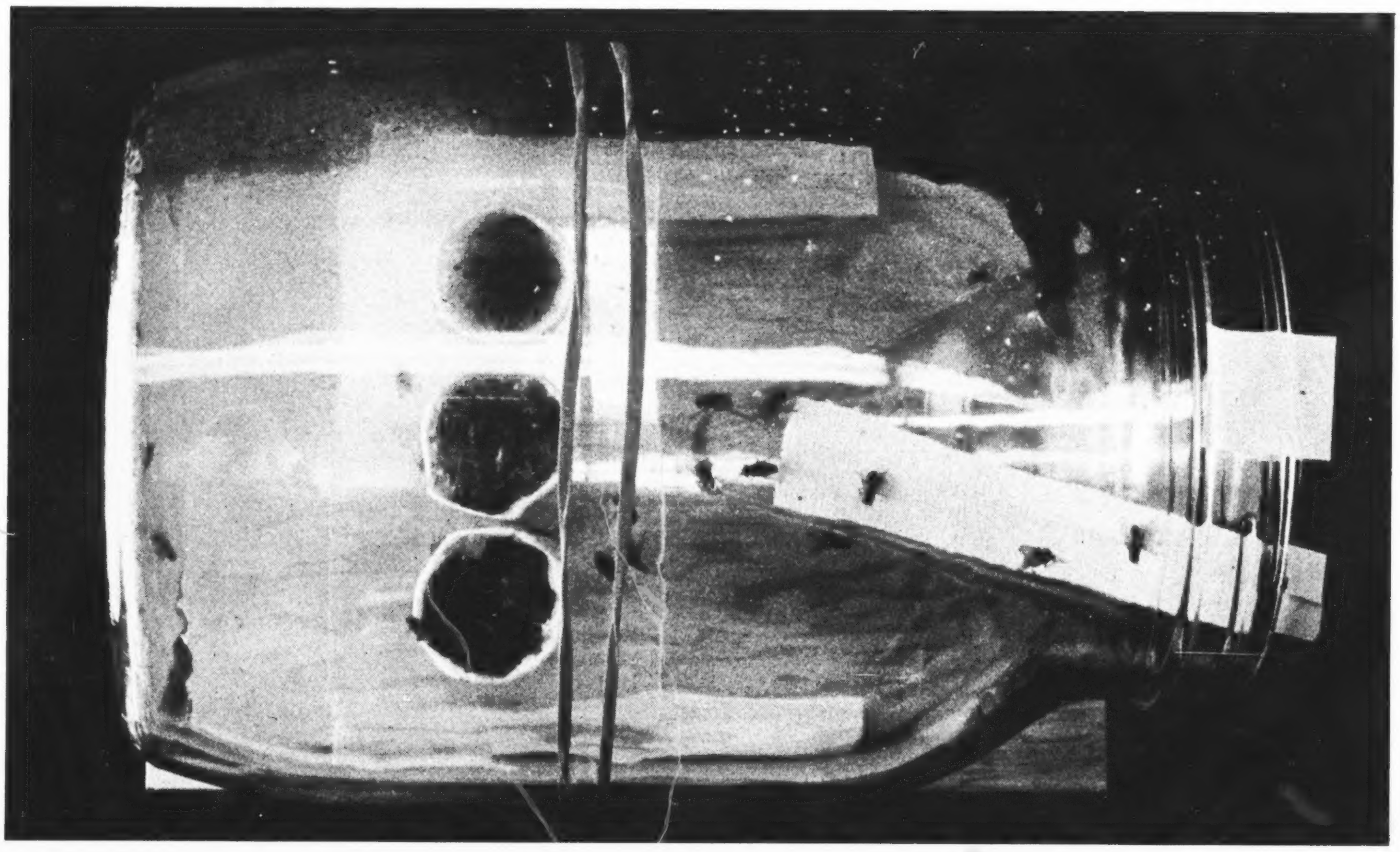

Figure 29

A paper cone (we used plastic sheeting for photographic reasons), with the tip snipped off to provide a small opening, is fitted into the mouth of the jar. In the jar is a three-holed feeding platform with souffle cups filled with liver, hamburger, and larval medium (sour milk worked just as well). The cone is taped to the mouth of the jar. Although it is relatively easy to get inside, it is somewhat more difficult to make an exit. It is, however, a simple matter to attach a sleeve and then remove the cone once you have trapped some flies. In this way we trapped about thirty flies. Strangely enough, they laid eggs only in the larval medium.

We want to emphasize that the trap has had its sole trial under "academic" conditions and has yet to prove itself in the "real" world. Our poor, docile, "kept" flies are hardly comparable to those brave souls who have won their spurs in the market-place; but given a reasonable concentration of flies, the trap should work. This summer in East Africa the trap will get an extensive "field trial". In the fall we hope to have something more tangible to report.

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APPENDIX III

KIM'S PUPA

Kim Olzewski, one of the fifth graders working with out experimental "genetics" materials, made a rather startling discovery while separating "grandchildren" pupae descended from the children of her original parental cross (red eye x white eye). She found a pupa with constriction near one end, giving it the appearance of an unbalanced "dumb-bell".

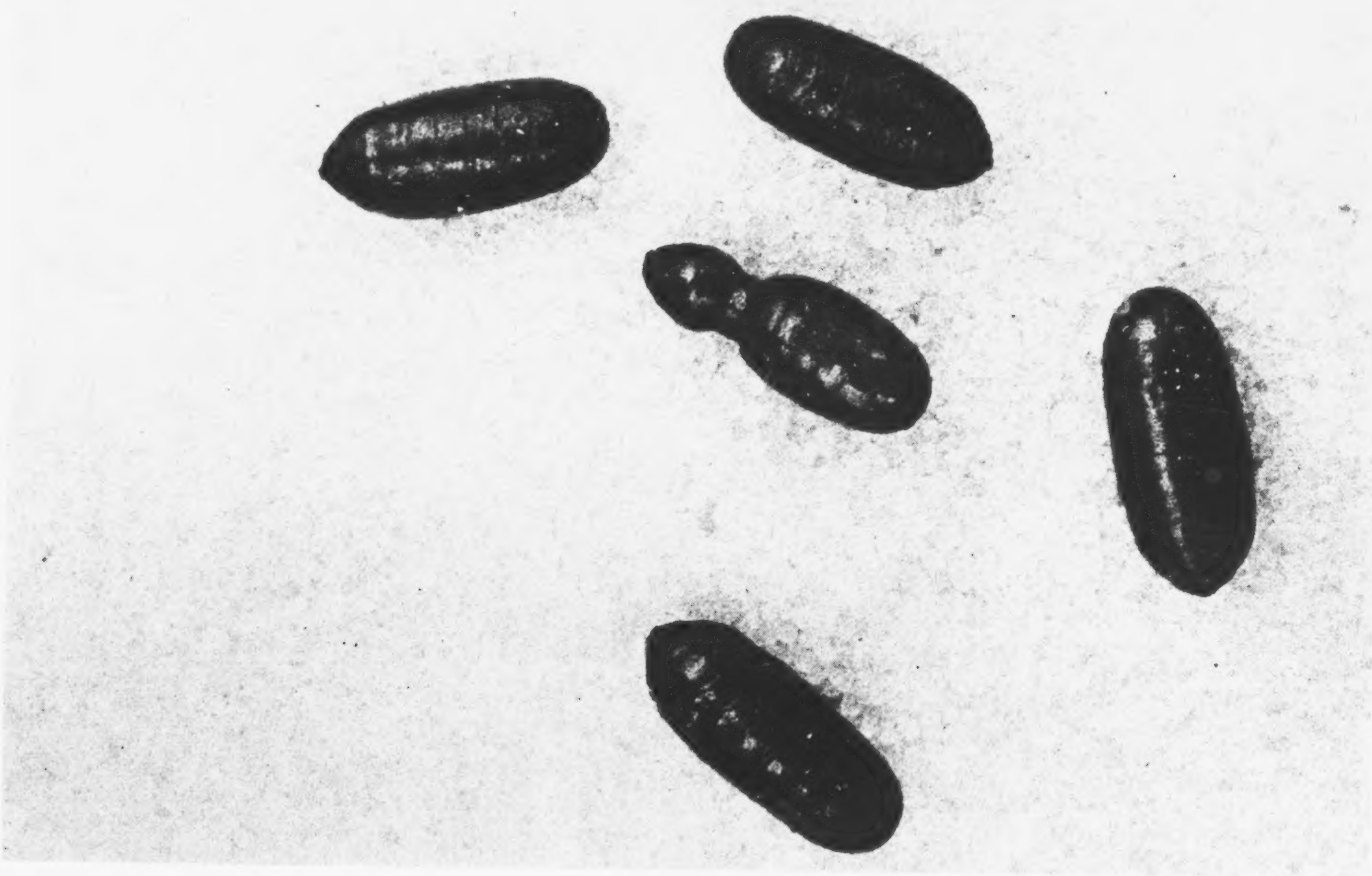

Figure 30

> Kim's pupa has a distinct "collar" at the point of constriction. Upon examination under a dissecting microscope, abdominal body parts appeared to be delineated in the larger "bulge"; while the smaller one seemed to contain the pinched-off head. When contrasted to "normal" pupae from the same batch, the "dumb-bell" pupa is striking.

Most pupae have a shape similar to wheat seeds, elongated ovular objects tending to a slight point at one end. Considerable variation in size occurs, however, both within the same larval culture and from one culture to another. "Abnormal" pupae show up quite frequently. One of the most common variants is shaped like a horn, as though the maggot pupated and retained its larval form. Others take on a "crescent" appearance. Kim's pupa, however, is unique as far as our laboratory is concerned. The question of whether its peculiar shape is an accident of development or reflects a more deep-seated hereditary variation can only be answered if the pupa produces a viable fly which will reproduce.

APPENDIX IV

PERIPHERAL AREAS

Experience with an organism so vitally alive as the house fly is bound to influence children in their creative expressions. So it did in an art class at the Webster College Experimental School. Balsa, buttons, beads, and baubles, among other things, were fashioned into a variety of representations of the fly. Figure shows, in panoramic proportion, some examples of fifth grade "impressions" of the fly.

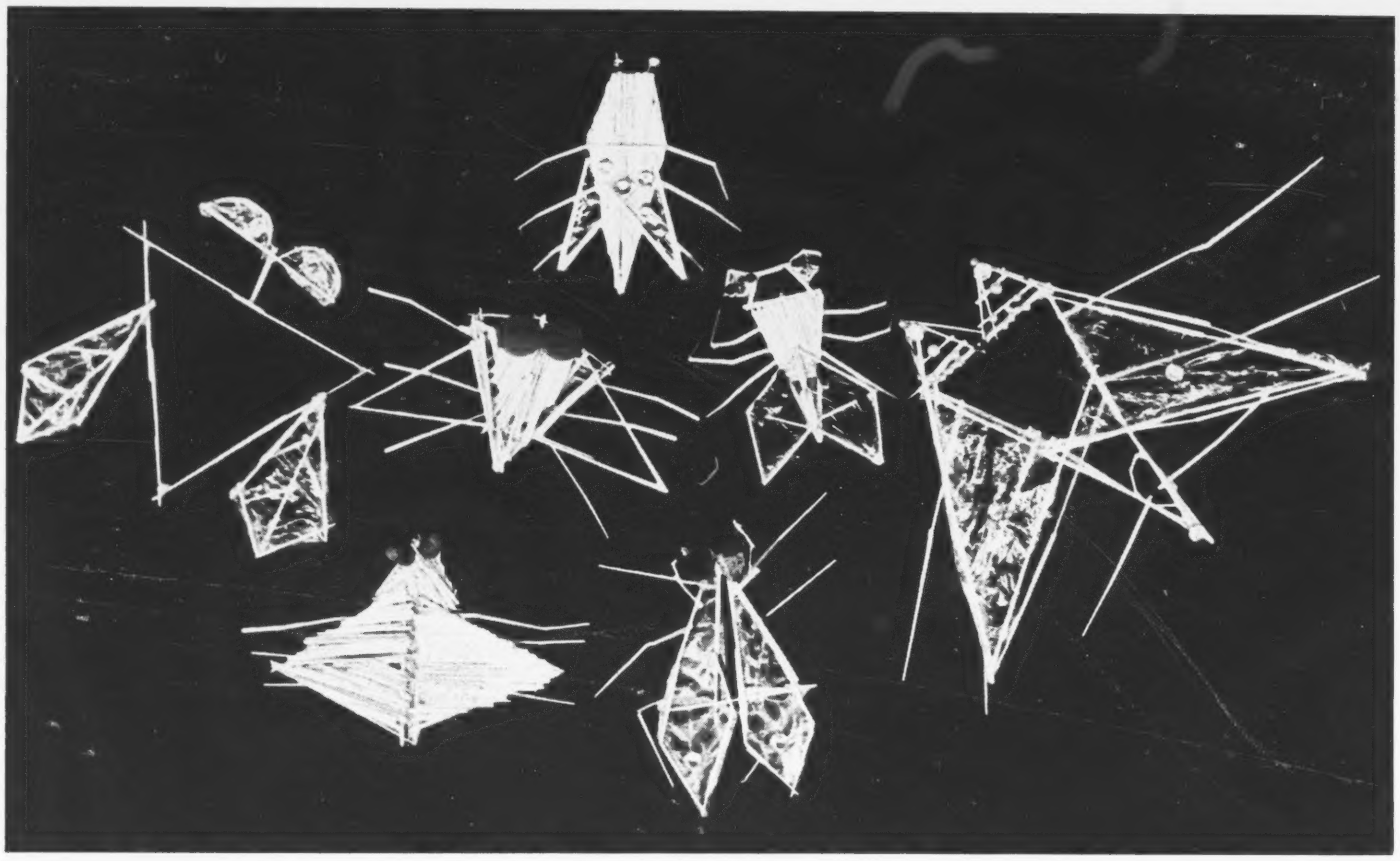

Figure 31

Yes, that object on the far left is a fly! Aerodynamically, it has a long way to go; but, as a "resting" fly, it has a fighting chance..... provided, of course, it is kept out of a high wind. The object on the extreme right defies definition. It's a bird, it's a plane, it's..... well, your guess is as good as mine.

The house fly is man's constant companion, and it is not surprising that the fly is mentioned frequently in his literary works. Among others, Shakespeare, Ogden Nash, and Haiku writers have used the fly as subject matter in their creative pursuits. More mundane literary works such as newspapers and weekly news summaries have also claimed the fly as copy material.

Surely the fly has affected the course of human history, both as an individual and as a member of a "horde". In a moment of reflection, one might conjure up an image of an agile, persistent fly pestering Hannibal on that "knoll" above the plains of Cannae, causing such consternation as to distract the great Carthaginian at the critical moment from signaling his heavy cavalry to circle the rear of the advancing Roman legions. But alas, to the everlasting sorrow of Roman arms, that fly apparently never appeared.

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The Fly Cycle

A commentary on the classroom film, A Linear Look at the Fly, a terminal lesson.

KATHY
MARCH 30
29
28
MARCH 27
MARCH 26
MARCH 25
MARCH 24

by **Paul D. Merrick**
Webster College
Webster Groves, Missouri 63119

A publication of the Webster Institute of Mathematics, Science and Arts (WIMSA), Webster College, Webster Groves, Missouri. This work was supported in part by a grant from the Bureau of Research of the United States Office of Education.
February, 1967

PREFACE

"A Linear Look at the Fly" was filmed immediately after the completion of a five week program of experimental science in The College School. Sixteen children, mostly fifth graders, participated in the filmed lesson. They were part of a group of forty-two youngsters from the fourth and fifth grades who worked through and helped shape the structure of the experimental materials. The size of the class used in the filming was limited by critical visual factors, not by any rigid selection based upon performance, etc. All of the youngsters had had a long, deep look at the house fly, each having set up and husbanded his own fly colony through two generations. The children have intimate knowledge of the developmental stages of the fly (egg, larva, pupa and adult), and they made many other observations of the organism as they cultured and handled it. The filmed lesson was designed to present a problem-solving situation to children in which they could bring their classroom experiences with the house fly to bear on the problem as they worked their way through it.

"A Linear Look at the Fly" is an unusual "lesson" --- unusual because it is highly unlikely that any other group of children will ever come to grips with the same problem again. The lesson would be virtually impossible to reproduce under ordinary classroom conditions. Fifty-four separate egg inoculations were made, three each day for eighteen consecutive days. To guarantee the availability of eggs each day during this period, a large number of stock cultures was maintained over a considerable period of time. Even in a laboratory equipped to raise large numbers of house flies, the task was very difficult.

The fact that this lesson is somewhat "artificial" and cannot be reproduced without great effort has some advantages. You, the viewer, can sit back and relax, knowing full well that you are not being indoctrinated with *the* "method" of presenting *the* "lesson". Instead, we hope it offers you the opportunity to observe a group of very perceptive children working through a unique problem.

Some idea of the nature and scope of the work the children had done prior to the filming can be gotten from reading the biological information and the account of classroom experiences in the parent document, *On the Fly*, and the related materials on heredity in *Even Flies Remember*. Both of these publications are available from WIMSA, Webster College, Webster Groves, Missouri.

Paul D. Merrick

Webster College
February 8, 1967

The house fly is an easy organism to culture in the laboratory or classroom. It feeds, breeds and lays eggs readily, regardless of season. If fly eggs are placed in a wet mix of grain-alfalfa, yeast and molasses, they will quickly hatch into tiny larvae, and these, in turn, will develop into mature maggots in four to six days. At the end of the larval development period, the maggot pupates and remains in this deceptively "inanimate" stage for about seven days. At first the pupae are flesh-colored like the maggots they came from, but they gradually darken, becoming deep reddish-brown in about twenty-four hours. About ten to twelve days after the eggs are put into the medium, the pupae "hatch" into the common house flies we all know so well. (See On the Fly, page 3.) If one were so inclined, he could inoculate a dozen or so jars with fly eggs, one jar each day, and portray the entire life cycle of the house fly, from egg to adult, in a kind of linear order (Figure 1).

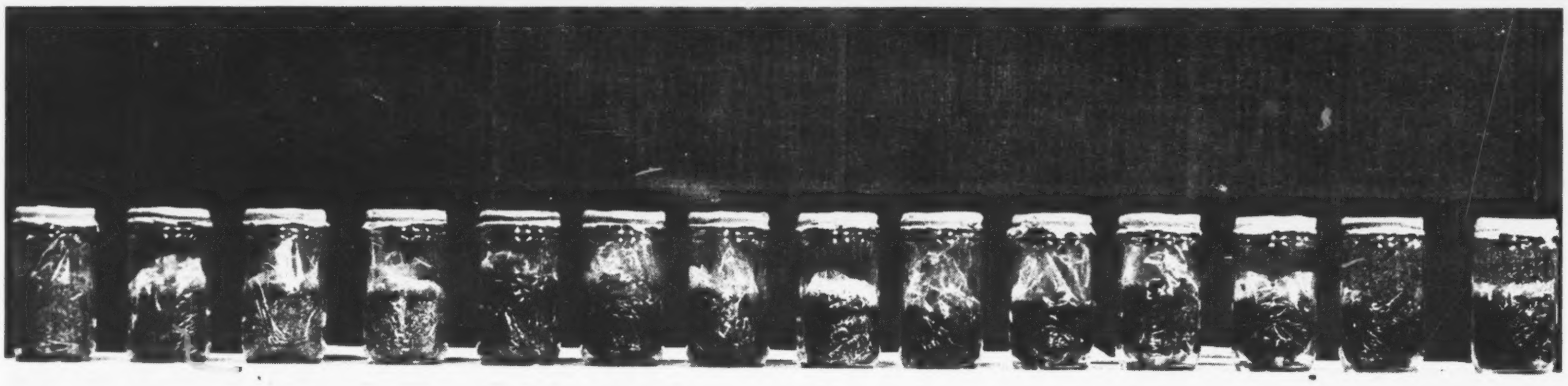

Figure 1

Each stage in the life cycle of the house fly (egg, larva, pupa and adult) is present in one or more of the fourteen culture jars. Thus the jar on the far left, which was inoculated with eggs on the morning of the filming, contains unhatched eggs which can be seen quite easily if the medium is spread out; while the jar on the far right contains adult flies, both living and dead. This jar was inoculated with fly eggs two weeks before the filming. Adult flies are clearly visible in the eleventh, twelfth and thirteenth jars, and the number of "fly specks" is an indicator of the time since emergence from the pupal case. The fourteenth jar is covered with fly specks, but most of the adults are now dead. Larvae and pupae are visible in some of the other jars. Note the change in the color of the medium as it ages.

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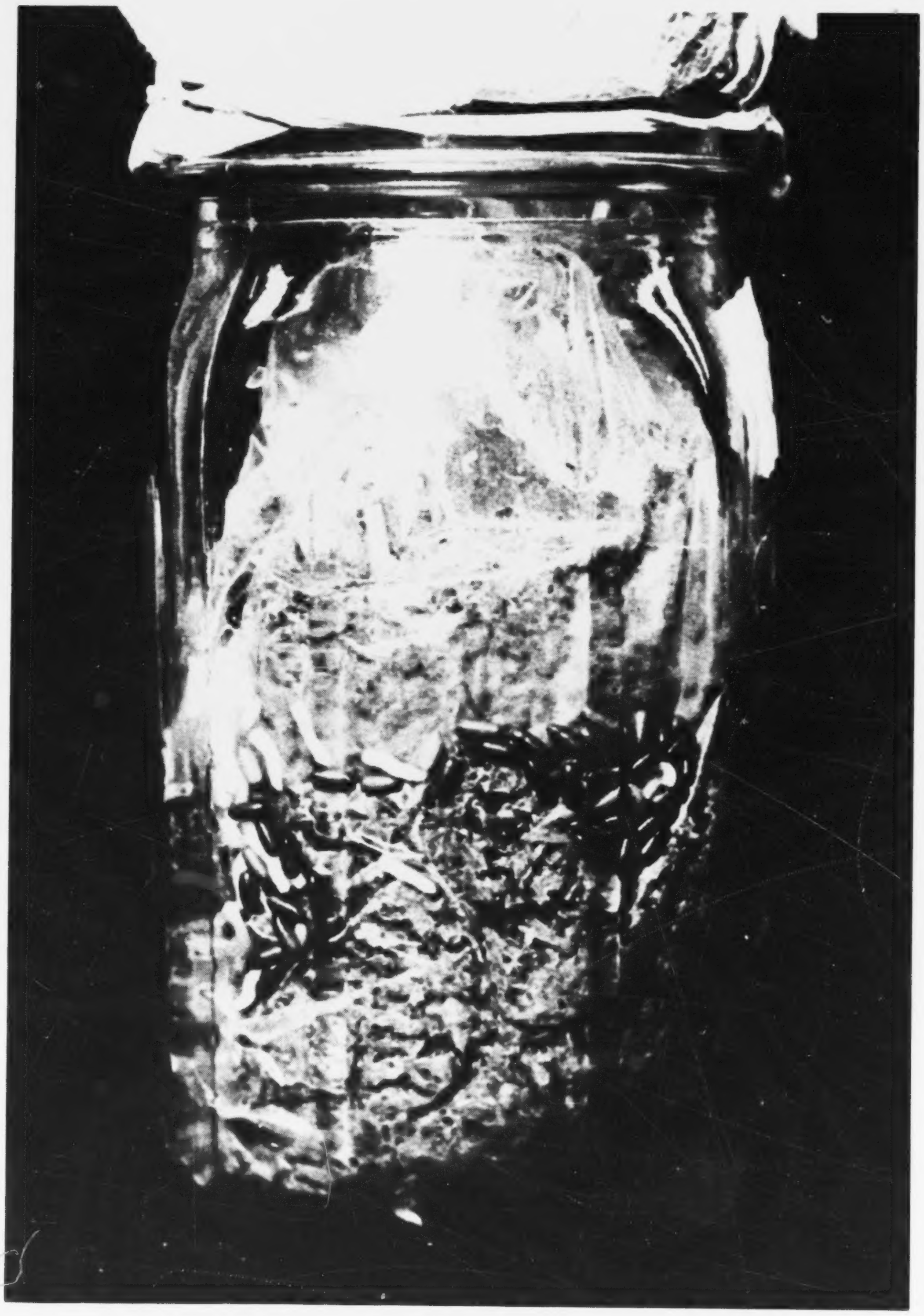

Figure 2

An unusual culture technique was used in the preparation of the biological materials for "A Linear Look at the Fly". Ordinarily one inoculates fly eggs into a jar or can containing larval medium and waits for adult flies to appear. The developing larvae usually remain hidden in the depths of the medium until a short time before the onset of pupation. Then for a brief period of time the maggots move about frantically, as if searching for a place to pupate, frequently coming to the interface of the culture jar and medium. Finally, they disappear into the medium again and pupate. For seven days the pupae lay beneath the surface, undergoing the remarkable series of changes which transform the simple, worm-like maggot into a complex adult house fly.

The culture technique shown in Figure 2 takes advantage of the maggot's tendency to "migrate" just before pupating. The medium is placed in a plastic bag and inserted into the quart jar, the plastic providing a liner between the jar and the medium. The larvae develop as usual for the first four days. Then about the fifth day, driven by some ancestral instinctive force, they begin their frantic search for a place to pupate. They crawl up the inner surface of the liner and then descend again between the plastic and the wall of the jar. There, in the "valleys" between plastic and glass, they pupate, generally accumulating in clusters at particular spots.

The culture shown in Figure 2 is about six days old. Many of the maggots have already become pupae, but a goodly number are visible on the left hand side of the jar. If you look carefully you can see all the stages of pupa case maturation from flesh color to dark reddish-brown. One pupa near the center of the picture is only a few minutes old; its light color can be contrasted to the maggot below and to the left of it.

With fourteen cultures of this type in daily sequence the entire fly cycle is visible except for the eggs and early stage larvae. The overlapping of the maggot-pupal stage, the progressive changes in the color of the pupal cases, and the emergence of the adult fly gives a dynamic picture of this fascinating process of complete metamorphosis.

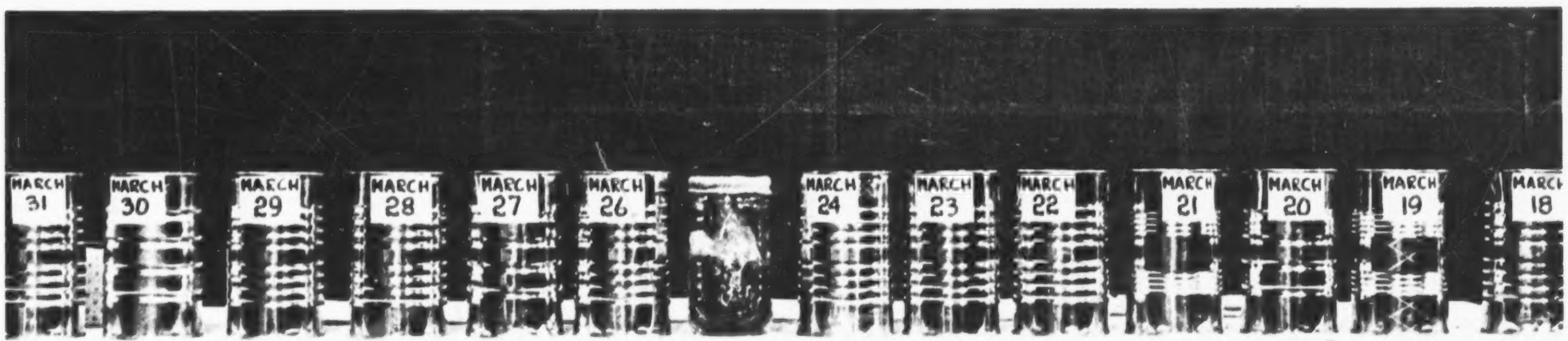

Figure 3

When the fourteen culture jars are covered with the dated cans, the ordered sequence of the fly cycle is masked. Instead of seeing the individual differences in the contents of the jars, one is presented with a kind of technological sameness..... a series of nearly identical food cans arrayed uniformly in a straight line. The date labels do little to break this linearity except, of course, to give direction and provide a means of identifying each can specifically.

This is the visual situation confronting the children when the filmed lesson begins.

. . . .

When Francis chooses to uncover the oldest culture jar (March 18), he unwittingly determines the course of the lesson. For although he does not see the few living flies (Louis does later), the many dead ones or the hundreds of white fly specks covering the inner surface of the jar, he does establish clearly that the experiment which was done each day involved flies in general and the larval medium in particular. Before much discussion can transpire, Kathy says, "To find out whether you started with eggs or larvae you'd have to use the March 31st one" (see front cover).

When she removes the can covering this jar, certain constraints have been fixed on the kinds of questions that can be asked and the kinds of problems that can arise. With the first and last jar in the series "uncovered", extrapolation is limited. The course of the lesson then turns inward towards interpolating between two clearly defined end-points.

In pre-filming discussions of the proposed lesson we were well aware that "he who lifts off the first can in large measure controls the course of events which follow". We might have devised a gambit whereby the teacher had "control" over which culture jar would be exposed first. "Indiscretion" was decided to be the better part of pedagogical valor, however, and the first move was left to chance. This decision also conditions the behavior of the teacher in the filmed lesson in that an operating strategy must be developed as the lesson evolves. Classroom lessons always seem to me to go best when youngsters have a part in determining the course of events..... and yet, I can't help wondering what direction the filmed lesson would have taken if an "inside" jar, similar to the one in Figure 2, had been exposed first.

. . . .

There is a peculiar inversion in the physical set-up used in "A Linear Look at the Fly". The age of the cultures increases as one moves from left to right in the series. The numerical value of date, on the other hand, decreases as one moves from left to right. This means that the youngest culture is covered by the can labeled with the highest numerical date. This inversion causes problems for many of the children. These problems are not too apparent in the earlier stages of the film, but by the time it is six or eight minutes old it is clear that there is confusion on this point. Nearly all of the responses by the children seem to have substance with regard to the biology of the fly cycle, but when an attempt is made to reason with reference to direction they get into trouble. At some time near the middle of the lesson, the teacher realizes that a number of children are "inverted" and makes a deliberate, if indirect, attempt to focus upon the inversion. This takes the form of following the dates through actual day names and explicating the fact that the culture in a particular jar had to have been inoculated with eggs on Saturday, March 27.

It is interesting to follow a specific example to see when an "inverted" youngster "rights" himself. In the early stages of the film, before the third can is removed (March 22), Meg says, "If you put eggs in March 18, there might be pupae in March 22." This statement is very sound biologically since it is common to find some pupae by the fifth day after egg inoculation. Meg, however, is working from the opposite end of the series and in the reverse direction. Later in the lesson Meg responds again at length to the question, "Suppose you were to lift off can 21, March 21.....?"..... Meg says, "I think I would find pupae still because like Gary said the ones there that have just changed (March 25) are light and the ones under the 22nd are very dark, and I think that they are about to turn into flies." Clearly, she has established direction from an intricate pattern.

The "inversion phenomenon" is an insignificant thing when considered in relation to the whole. It is, however, an indicator of the subtle factors which can lead to misunderstanding, or worse, outright misconception. When one considers the possibility of a series of such insignificant factors added together in sequence, it leads to an interesting hypothesis as to why children and/or adults have difficulty with mathematics or quantitative science.

. . . .

Figure 4

The "long black line" is broken.

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Some idea of the involvement of the children in "A Linear Look at the Fly" can be gotten from the pictures in Figures 4 and 5. When the Audio signal, "Cut", was given and the set crew began shuffling about, the children realized that the filming was over. Once freed from the strictures of being "on camera", many of the children migrated to the front desk and proceeded to examine the "long black line", removing the remaining cans, and carrying on a delightful discussion about the whole problem. Some of the other children, however, chose to remain at the back of the room and continued pawing through the larval medium to find the last egg or larva.

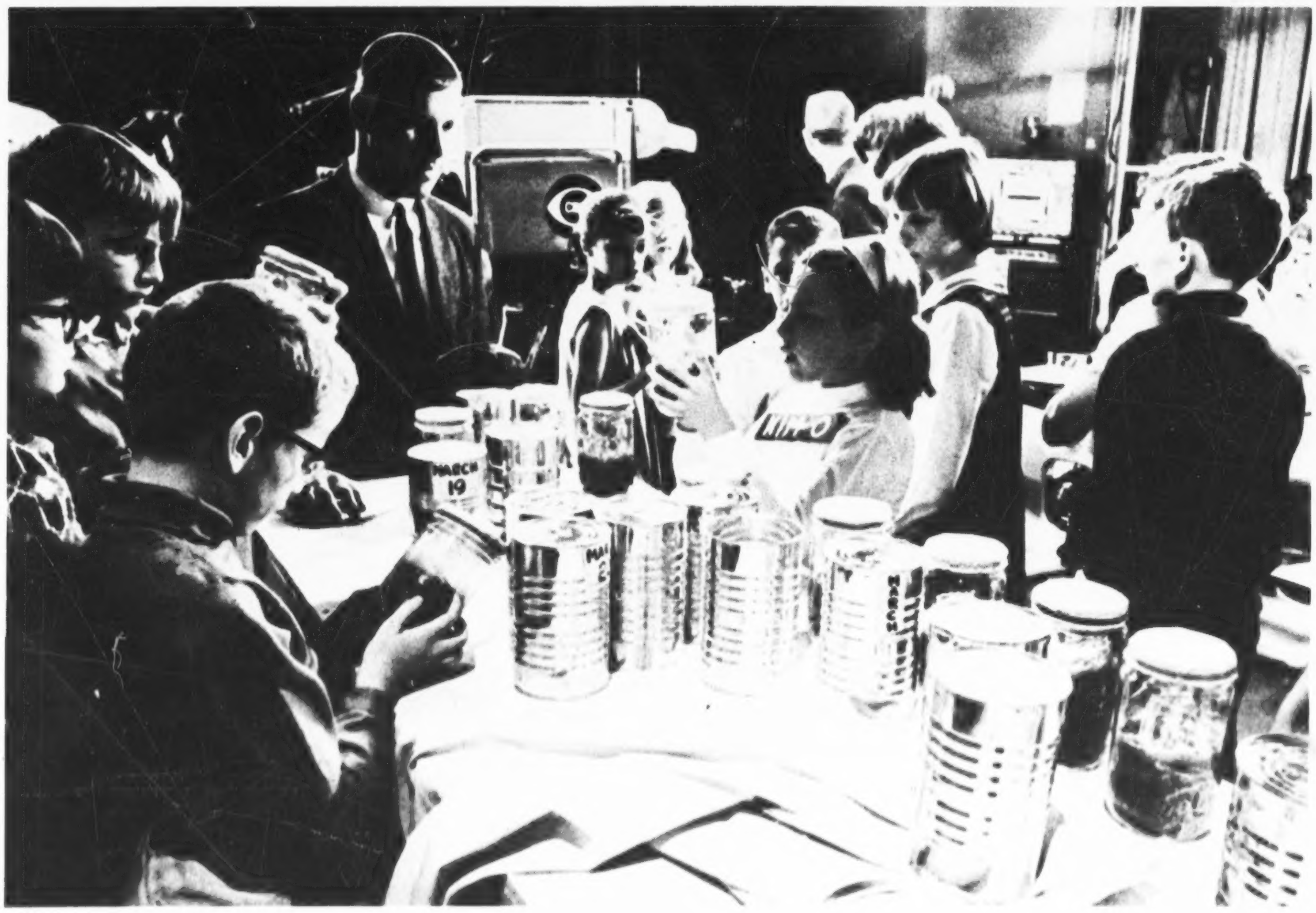

Figure 5

Five minutes after the director said, "Cut", there was still "action" at the front table!

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Fly Culturing

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Fly Culturing

THAT steadfast companion of man, the house fly, has taken a long term "lease" on quarters at Webster College. To be sure, the flies reside in their own little "ghettos," but almost everyone on campus has been "touched" in one way or another by these busy little creatures. Students in the regular college program made contact through a new experimental Biology I course. In-service teachers came to know *Musca domestica* through its nighttime capers in the evening classes of the Master of Arts in Teaching program. Some students cultured the fly through its life cycle and then pursued individual problems ranging from maze-running to birth-control studies. The courses for adults in the college program have stressed direct involvement in a continuous laboratory environment with lectures and other "external" information playing a subservient, but significant, role.

But it is the experience of the fourth and fifth graders that concerns us here. During the past two years, more than 250 Websterites, from ten to eleven years old have had the most intimate experience with the fly in the Experimental School at Webster College. No adult, for example, ever had the inclination to organize a fly "funeral" or dubbed the egg-larvae cultures "fly nurseries." And none of the adult groups ever displayed maternal and paternal instincts which demanded that every fly egg be hatched, every larvae nurtured, every pupa saved, and every resulting adult be properly "housed."

Husbandry Techniques

The house fly is an easy organism to culture under classroom conditions. It feeds, breeds, and lays egg readily, regardless of season. Using the culture techniques described below, fly colonies are clean, virtually free from "smelly" odors, and, above all, practically indestructible. During its life cycle (approximately sixteen days from egg to egg), the house fly displays four distinct stages, all of which are readily observable and easy to manipulate.

House flies display complete metamorphosis, the egg hatching into a tiny larva about twelve hours after it is deposited by the female. The larvae develop in three stages (instars), reaching the mature maggot form in four or five days. The maggots pupate and remain in this seemingly "inanimate" stage for six or seven days. The adult flies then emerge from the pupal case, mating in two or three days. By the fifth day after emergence from the pupae, and with abdomens swollen, the females begin to deposit eggs. A single female may "lay" 600-800 eggs

Eggs will hatch into larva about twelve hours after being deposited under the surface of bran mixture.

during her lifetime, sometimes as many as 175 within a one-hour period.

Adult flies are kept in cages made from gallon jars. A gauze or light cloth "sock" is attached to the mouth of the jar to provide access for feeding and maintenance chores. In addition to a continuous supply of water, a small container filled with dry milk will provide the complete source of nutrients required by the flies.

The collection of eggs and the culture of larvae are closely related operations. Female flies seem to prefer a place to "hide" their eggs in preference to any specific kind of nutritive materials. They are apt to lay their eggs anywhere in the cage, particularly under something. However, a mixture of bran and diluted canned milk is a "sure-fire" attractor for pregnant females.[1] If the mix is offered in a small container, the females will accumulate on the surface and deposit eggs. Few, if any, eggs will be seen on the surface of the bran-milk mix; the females extend their ovipositors down into the medium to hide the eggs. A little probing will uncover masses of fly eggs beneath the surface. A colony containing fifteen or twenty females is apt to produce up to two thousand eggs at a "sitting." Females will continue to lay eggs for three or four weeks, or longer.

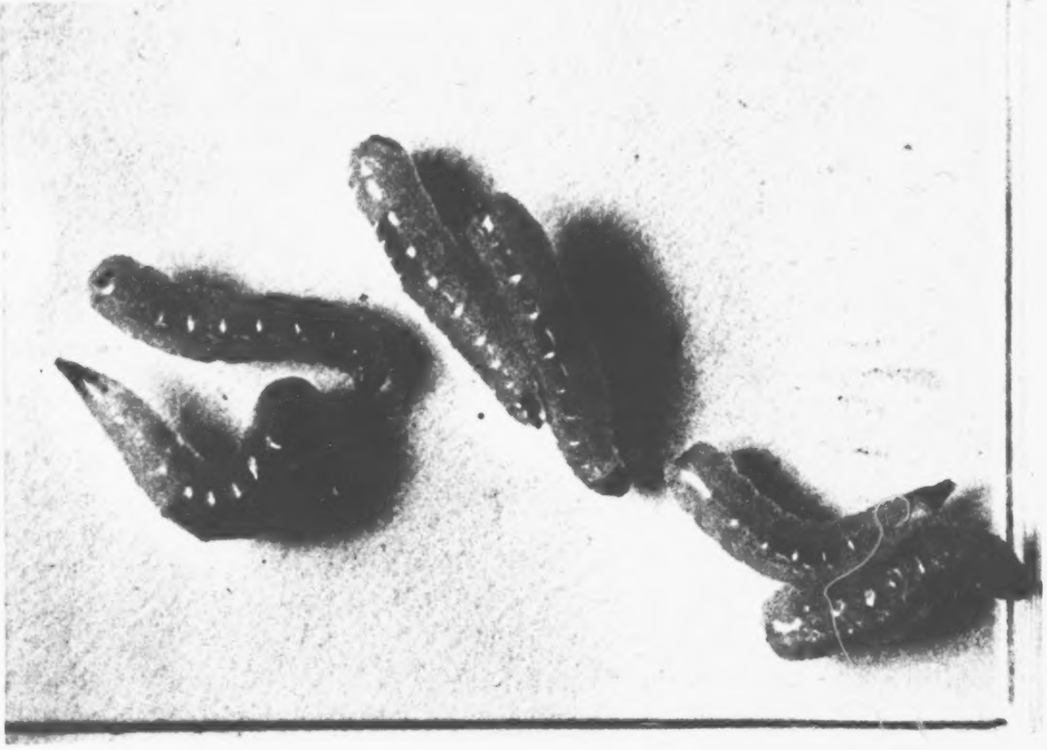
The culture of fly larvae is the trickiest part of the entire operation. Flies seem to have little trouble perpetuating themselves in nature, but the laboratory culture of larvae can be subject to some complications. Molds are the biggest problem. Following a few simple rules, however, will result in hundreds of successful larval cultures in succession without a failure. After much research into the problem, we have developed a technique which is almost fool-proof—provided one sticks reasonably close to the procedure. A deep plastic petri plate (100mm x 20mm) is filled loosely with the bran-milk mix. One hundred to two hundred fly eggs are inoculated into the medium. The plate is then covered with the lid. For best results, the air space between lid and medium should be very small. Molds require a rich air supply for good growth, while fly larvae do very well in "airs" of low oxygen content. But the larvae require some oxygen, however, and one has to be careful that a water seal (from condensation) does not form around the inside of the lid. If this happens, the larvae usually come to the surface and die. At times, no larvae will be visible in the plate. This is apt to "worry" even the most experienced fly husbander, particularly if the culture is part of a critical experiment. Actually, the larvae are almost always there, just avoiding light. If the lid is lifted off and the plate held near your ear, you can "hear" the larvae moving about in the mix. They make an awful "racket" when they are three or four days old.

There are many subtle factors which affect larval cultures. If too large a number of eggs is used, second instar larvae will leave the medium in droves. On the other hand, if few eggs are put in (or the eggs have a low viability), the culture will often be blank. Too high a temperature slows down the development of the culture. The best "rule of thumb" is to place the culture away from any prolonged cold spot in the room and lift off the lid periodically.

Maggot Migration

One of the most exciting events in the larval culture phase is the "migration" of the mature maggots. Just before the onset of pupation, the fat maggots stop feeding and move "endlessly" around the periphery of the culture plate, often wearing a "track" around the top of the medium along the plate wall. Sometimes the maggots actually exert

Larvae develop in three stages reaching the mature maggot in four of five days.



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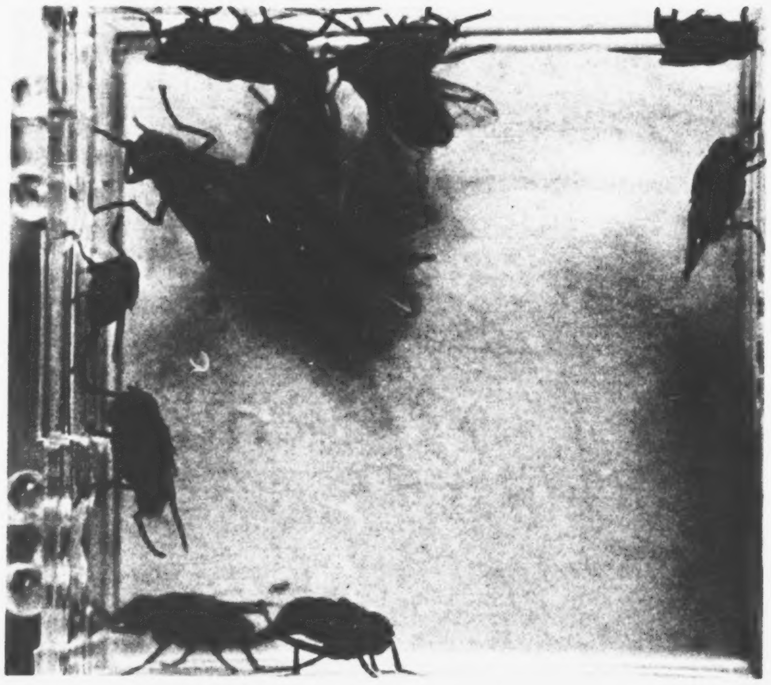
[1] The optimum formula for the bran-milk mix is two volumes of dry bran to one volume canned milk diluted with water (one volume of milk to four volumes of water). The same bran-milk mix is used for "egg cups" and larval culture.

Maggots change rapidly into the pupal stage by the seventh day after the eggs have been inoculated into the medium.



Adult flies emerge from the pupal stage about six or seven days after pupation has begun.

sufficient pressure to raise the lid, and they escape from the medium and scurry off to find a suitable crevice in which to pupate. This migratory urge is instinctive in maggots.[2]

The process of migration, or rather the end-product of the process, can be observed by manipulating the culture a bit. About the fourth day after egg inoculation (or when the fat maggots can be seen readily), we set the petri dish in a larger bowl or plastic container and remove the lid. As soon as they have the "urge," the maggots crawl over the edge of the petri plate and drop to the floor of the bowl where they form pupae. It is a good idea to put something between the bottom of the petri plate and the bowl. Otherwise, the energetic maggots "burrow" between the plate and bowl and pupate (you can actually see the plate being moved about by "maggot pressure"). If the maggots are permitted to pupate under the plate, the pupae are apt to be flattened and produce few flies.

Starting A Colony

The easiest way to start a fly colony is to obtain 20-30 pupae from a commercial supply house or from a local university, if it happens to be maintaining stock fly cultures. However, there is nothing to prevent the serious "do-it-yourselfer" type from catching wild flies and starting a culture from the great out-of-doors reservoir of flies. We have had occasion to do this many times in our work. In fact, we developed a "fly accumulator" to make wild fly trapping easy. A fly accumulator is made by fitting the mouth of a small jar with an opaque paper funnel, the small opening of which is frayed slightly. Flies detect lateral motions much easier than vertical ones which have their origins from positions directly "over" them. With a little practice one can "lower" the fly accumulator over the unsuspecting fly with amazing success. Once trapped inside the dark funnel cone, the fly quickly makes his way to the disc of light at the tip and "escapes" into the fly accumulator.

A word of caution, however, about starting a colony with wild flies. Quite often wild fly populations will have a disproportionate number of males, sometimes running as high as 90 percent. Strangely enough, the *high male factor* is apparently inherited, since it persists over many generations of laboratory culture. Even if you trap all females, each successive generation will have to have the sex-ratio balanced by selective counting.

Experiments with House Flies

Once the problems of routine husbandry have been mastered, there are many "little" experiments one can do with house flies. Simple nutrition experiments present an amazing variety of problems, many of which are easily performed by eleven year olds. Problems of breeding offer an avenue into the biological aspects of sex education. Many mutant types are known for the house fly so that heredity studies can be made by fifth and sixth graders. Eight youngsters from the Webster College Experimental School have actually made the critical crosses which lead to a rudimentary understanding of heredity.

Much additional information about the house fly is available from the Webster Institute for Mathematics, Science and Arts (WIMSA). *On the Fly, The Fly Cycle,* and *Even Flies Remember* are publications produced by WIMSA under grants from the U.S. Office of Education and the Carnegie Foundation. Copies of these are available free of charge to persons in education by writing to the author at WIMSA, Webster College, Webster Groves, Missouri 63119.

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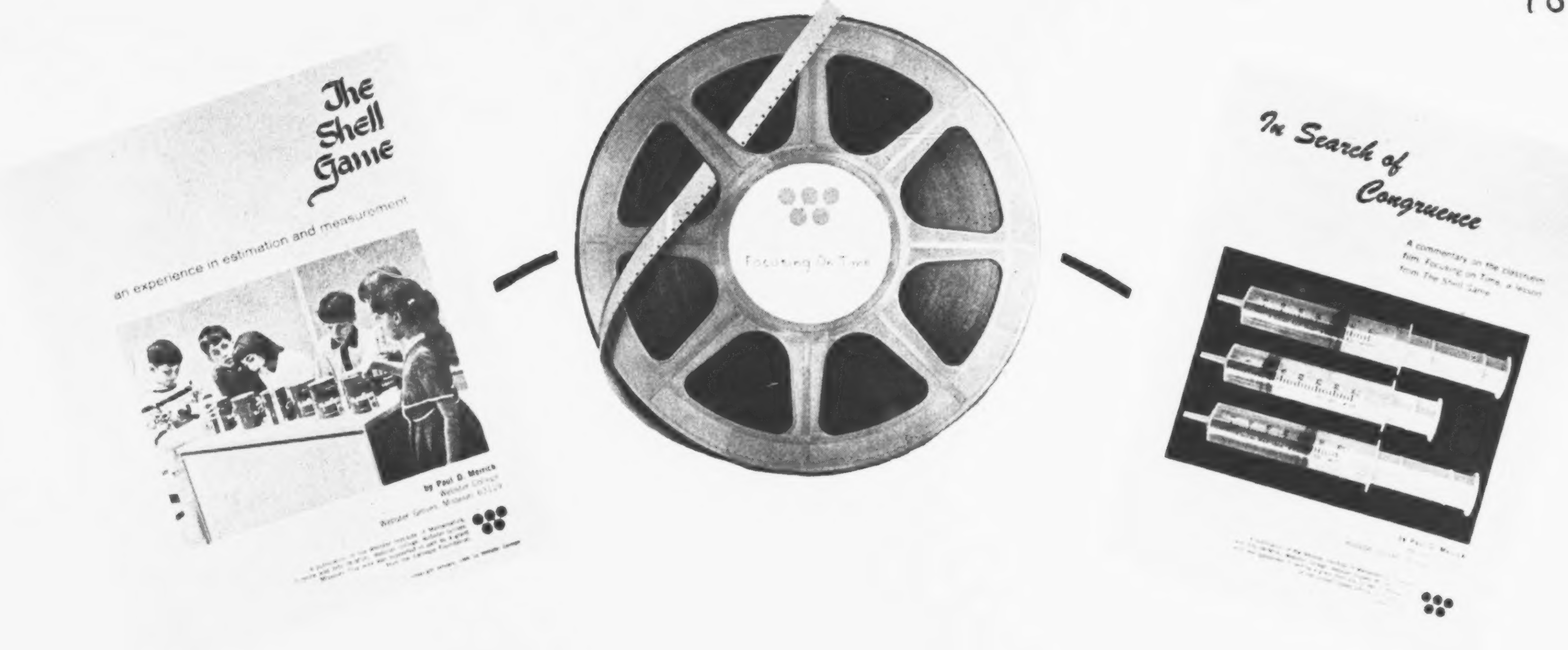
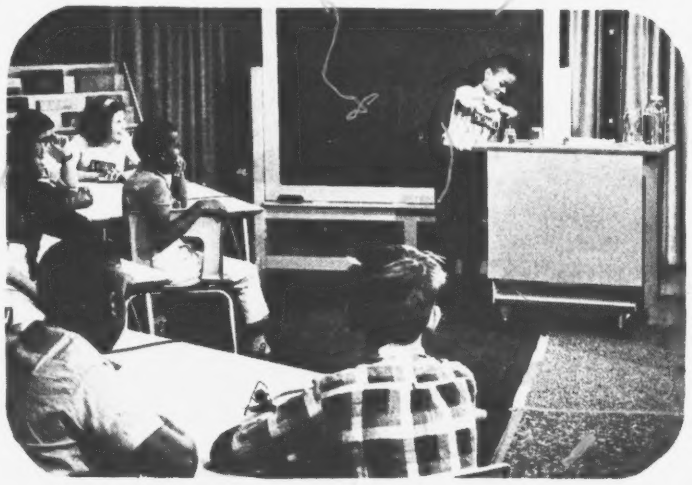
[2] The maggot migration phenomenon has been the subject of intensive investigation in our laboratory. Helen Eckelkamp, a Webster College student, has written an excellent research paper on the subject, *Migration of House Fly Larvae.* The mature maggot seems destined to be the subject of an "animal behavior" block for elementary school children.


The Shell Game
an experience in estimation and measurement
by Paul D. Merrick
Focusing On Time
In Search of Congruence
A commentary on the classroom film, Focusing on Time, a lesson from The Shell Game.



Focusing on Time was filmed in the Admiral Byrd School located within a large public housing development just west of the Loop in Chicago. The class was composed of fourth, fifth and sixth grade children from several different schools in the Chicago area, and from a variety of socio-economic environments.

Most of the children were strangers to one another, and all were strangers to the teacher.

Webster College, through the Webster Institute of Mathematics, Science and the Arts, is producing curriculum materials for in-service and pre-service teacher training programs. These materials are designed as "models" to present alternative approaches to the teaching of science in the intermediate grades of the elementary school. The research and development of these models has been financed by the Carnegie Foundation and the Bureau of Research of the U.S. Office of Education.

Each of the models will consist of an original subject matter scheme, a classroom film showing children working through some phase of the subject matter scheme, and a teacher commentary which focuses on the main themes of the filmed lesson.

The first of these models has been tested nationally by thirty-five trial groups including universities and colleges, local school districts, state departments of education and selected "specialist" groups. The classroom film, *Focusing on Time,* along with its supporting subject matter scheme, *The Shell Game,* and the teacher commentary, *In Search of Congruence,* has proved to be an excellent vehicle for stimulating teachers to discuss the teaching process.

WIMSA, Webster Institute of Mathematics, Science and the Arts, Webster College, St. Louis, Missouri 63119

____Please send the one free copy of *The Shell Game* with teacher commentary *In Search of Congruence*

____Please send ____copies of the package containing *The Shell Game* with teacher commentary *In Search of Congruence.* (.20 per pkg.)

Please send film *Focusing on Time* for use on ________________ ; alternate date ________________.

____ $5.00 (covering insurance both ways and handling charges) is enclosed. Charge covers one week's use following receipt of film.

____ $5.00 handling charge will be sent upon receipt of film.

Mailing address including zip code:

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BUILDING GENETIC MODELS WITH FIFTH AND SIXTH GRADE CHILDREN

The experimental work on heredity described in this paper was carried out with eight fifth grade children from the Webster College Experimental School in the late spring and early fall of 1966. Prior to this work these youngsters had participated with thirty-six other fourth and fifth graders in the development of an experimental block of biological science concerned with the life cycle and husbandry of the house fly. In June of 1966 the Webster Institute for Mathematics, Science and Arts (WIMSA) published the curriculum resource document, On the Fly, describing the experiences in the experimental school. On the Fly is the background experience the eight children brought to heredity work.

A paper prepared for presentation at the
National Science Teachers Association
Convention in Detroit, Michigan
March 19, 1966

By
Paul D. Merrick
Assistant Professor
of Biology
Webster College
Webster Groves, Missouri

In recent years heredity in the house fly, Musca domestica, L., has been studied in detail in several laboratories throughout the world. The incentive for these studies has been due, in part, to the widespread use of the house fly as a test organism for laboratory studies, particularly with regard to insect control and toxicology. In a sense, Musca is the entomologist's "white mouse". As a result of the genetic studies of the fly, many mutant strains are now available, particularly for eye color. Red is the normal eye color of wild flies; but white, green, carnation, carmine, ruby, and ocra eye-color mutants have been described. The gene for red eye color, however, always seems to be dominant over the mutant types.

We selected the house fly for heredity studies with children for several reasons. 1.) We had extensive experience with the organism in laboratory culture. 2.) The children we intended to work with had already mastered the husbandry techniques needed to maintain house fly colonies over the long periods of time necessary to obtain the essential data for model building. 3.) The separation of the sexes is relatively easy. 4.) Most important, however, is that eye-color inheritance in Musca is not sex-linked as in Drosophila.

The inheritance of eye color in the house fly (red and a mutant type) displays the classic Mendelian pattern of simple dominance and recessiveness. When pure line reds are crossed with pure line whites, for example, the F_1 generation is all red. Subsequent crossing of F_1 reds produces an F_2 showing the classic ratio of approximately three reds to one white.

With eleven year old children, the traits studied must be strikingly different and easily identifiable. The eyes of house flies are large, covering more than half of the surface area of the head. Red, white, and green eyes are easily distinguished from one another. A white-eyed house fly is identifiable up to ten feet away

After browsing through our supply of mutants, the eight children who participated in the experiment were free to choose the crosses they wished to make. The possible crosses were arrived at by means of an array diagram of male and female types.

MALES

		red eye	white eye	green eye	brown body
FEMALES	red eye	----	RW	RG	RB
	white eye	WR	----	WG	WB
	green eye	GR	GW	----	GB
	brown body	BR	BW	BG	----

A system of elimination was used to arrive at the different possible combinations and their reciprocals. The children favored eye-to-eye crosses, but two youngsters decided to take brown body x white eye and its reciprocal. (In house flies this is a complex cross, but it produces interesting F_2 results.)

After the crosses had been made and the children had F_1 pupae in hand, we asked them what they thought the "children" would look like. Every "rumor" they had ever heard about heredity became the basis of an hypothesis. They would be like their mother, like their father, halfway between, unlike either, one eye one color and the other another color.....

The Results

The F_1 were a great disappointment to the children, particularly those who had crossed white eye and green eye -- everything came up RED-EYED and normal bodied. The children who crossed WG and GW were not only disappointed; they showed signs of bitterness.

Each youngster then crossed males and females from the F_1 and awaited the results. This time when we asked them what they thought the grandchildren would look like, they were not so confident or positive. Most of them had taken on skeptical attitudes. Some expressed the opinion that they had "lost" one of the eye colors, while others thought it might reappear.

When the grandchildren were "born", there was much elation about the reappearance of the "lost" traits, particularly on the part of the four youngsters who had made the red-white crosses and the red-green crosses. For the others, however, frustration was the rule. The grandchildren of the original green-white crosses showed several different eye colors including red, white and green among others, but the grandchildren of the brown-body, white-eyed cross failed to produce a single white-eyed, brown-bodied house fly.

Building Genetic Models

Once the data from the F_2 generation had been tabulated (for some youngsters this involved taking their F_2 pupae to the College School camp), we assembled the youngsters at KMOX-TV in St. Louis on May 19, 1966, and produced the filmed classroom lesson, "Mendel Revisited", a forty-five minute videotape in which the youngsters revealed their own results and tackled the problem of analyzing the data from one of the red-white crosses. In the process of doing this, the children formulated the principle of dominance, or "overtaking" as one youngster termed it, and arrived at a two-factor system to explain the results of Tom's red-white cross. In the process of doing this, three or four "models" were built to explain the results, the last one of which was breathtakingly close to Mendel's original model for simple dominance.

In September of 1966, nearly four months later, the children were reassemble and the film was shown to them. Then we picked up where the filming had left off and built one "last" model -- one which Mendel himself would have approved.

One month later (October of 1966), without any intervening "lessons", we again took the children to KMOX-TV and filmed the classroom lesson, "Building Genetic Models" (fifty-five minutes). In this sequence the youngsters were confronted with a "foreign" situation - data concerning intermediate inheritance in Shorthorn cattle. The film shows the youngsters proceeding from "scratch" to the formulation of the 1-2-1 model characteristic of incomplete dominance. Prior to this the children came to grips with phenotype, genotype, heterozygosity, homozygosity and test crosses, albeit with their own terminology.

A nine minute film clip, exerpted from "Mendel Revisited" and "Building Genetic Models" will be shown.

Conclusions

The results of our work in heredity indicate that youngsters can build models based upon "real" data. However, a good deal of "free" exploration seems to be necessary before "closure" on a particular model is practical. Given an "in-depth" experience with the simple dominance pattern, our children readily transferred certain general notions and built a model for intermediate inheritance based entirely on a vicarious experience.

. . . .

A more detailed description of this work is available in the WIMSA publication, Even Flies Remember (thirty two pages). The classroom films, "Mendel Revisited" and "Building Genetic Models", are also available. In addition, much valuable background information is contained in the publications On the Fly, The Fly Cycle, and the classroom film, "A Linear Look at the Fly".

For information write:

WIMSA
Webster College
Webster Groves, Missouri 63119
Attention: Paul D. Merrick

LABORATORY WORK - A View from a Different Angle

Presented at the National Science Teachers Association Convention, New York City,
April 3, 1966, by Paul D. Merrick, Asst. Professor of Biology, Webster College

Traditionally, the laboratory base of science courses has been the discontinuous phase, sometimes unnecessary oftentimes irrelevant and always subservient to the verbal phase. Perhaps over the long haul this relationship between direct and vicarious experience is unavoidable, an outgrowth of the complex of limited time and the pressure to "cover" the enormous subject matter reservoir we call science. It seems to me, however, that the kinds of experiences a student can have in the laboratory need not always be fleeting glimpses of reality interwoven into the rapidly-paced rationale developed in a series of lectures. Stimulating, important learning experiences can be had through laboratory investigations which evolve from their own base with a minimum of external structure by way of the written or spoken word. I do not propose that we stop communicating verbally or tell our students not to read, far from it. Rather, I suggest that there are some aspects of science which are best approached through first-hand experience that only laboratory work can give. On occasions we should let the laboratory stand on its own merits to the limit that is possible.

This year at Webster College we have been experimenting with just such a scheme; we call it the Continuous Laboratory Approach. The house fly, *Musca domestica* L., has been used as an object organism, and the laboratory has been allowed to evolve from observations of this common representative of the dipteran world. Students progress from culturing the fly through its life cycle to work on individual problems resulting from questions they, themselves, have asked of the fly. At the beginning everyone was doing essentially the same thing. At the end everyone was doing something different.

Last fall two classes of freshman students wrestled for eight weeks with the realities of life through the vehicle of the earthly concreteness of direct experience. Subsequently in-service teachers in our Master of Arts in Teaching program have come to know the house fly intimately. Currently, thirty-five liberal arts majors are investigating the habits needs, and vagaries of this constant companion of man. (We have also used an attenuated version with fourth and fifth graders in the Webster College Experimental School. Just last week we made a classroom film, A Linear Look at the Fly with sixteen children participating.)

The choice of subject matter for the Continuous Laboratory is of prime importance. Regardless of whether the course deals with Chemistry, Physics, Biology or some combination of these, the nature of the materials under consideration has to be compatible with the laboratory approach. We chose the house fly as the object of investigation for our experimental effort, partly because it is an extremely easy organism to culture and observe, and partly because its life cycle is relatively short (18 days), and it displays four distinct stages. Egg, larva, pupa, and adult appear in sequence guided by an ethereal timetable built into the fly. Each stage in its turn determines daily activities in the laboratory for the first three weeks of the course, and provides a sequencing of events which gives rise to the base of the Continuous Laboratory Approach.

The course is divided into four or more less distinct phases:

1. A husbandry section dealing with the culture of the house fly from pupa to pupa. The first three weeks everyone faces a set of similar problems.
2. During the last five weeks students pursue individual problems. (Most of our students had never before had an opportunity to define a problem and pursue it.)

3. A "model" of aerobic respiration is built. From the question, "does a fly breathe," to a sophisticated Warburg-type rate measurement, we ask our students to build the model step by step on experimental evidence.

4. Eight lectures, each keyed to the laboratory, and after the fact, are given at irregular intervals. The essential feature of these is to explore broad biological ideas in a context which relates the lectures to concrete experiences. The content of these presentations could be subject to wide variations, and a different teacher might choose an entirely different set of ideas for exploration.

Sometimes we forget that most of the learning experiences all of us have had did not come from a book, a lecture, or a capsulized account of an event to which we were not witnesses. None of us would ever have learned to tie our own shoelaces if our sole experience had been some verbal instruction and a single demonstration of the act. Why should we presume that the only pathway by which an individual can have worthwhile experience in science is through the medium of the written and spoken word, condensing a broad range of experiences into a few paragraphs? Out where the "cutting edge" of the sword of science is exploring the unknown, the approach is primarily phenomenological, different in degree parhaps from the modus operandi of a Galileo, a Gay-Lussac, or a Pasteur, but certainly not different in kind. The scientific process (whatever that may be) is, in the main, not accesible through vicarious experience; we are deluding ourselves if we operate on the premise that it is.

I do not think we have even scratched the surface in identifying the kinds of learning experiences, compatible with an academic framework, which lead to real understanding of the nature of science. As a start, however, we might entertain the idea of divorcing some of the traditional laboratory work from the context of lecture-text dominance, and use this time to learn what can only be learned through practical experience, in depth. In competition with expository presentation, where time and coverage are the chief parameters which guide us, the laboratory sinks quickly to a second rate activity - or worse, a negative experience.

I think the profession is sorely in need of innovative efforts which explore new ways of coming at this vast entity we call science. The last decade of curriculum development has broadened the views of all of us with regard to inquiry and process, but the same boundary conditions of course structure still bridle us. I hope there are others among you who will pick up the gauntlet and help break the log jam created by the "standardized" mode of presentation to which we are all enslaved.

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FINAL REPORT, Curriculum Innovation in the Fields of History, Science, Music, and Art within a Single Institute, 9/1/66-5/31/67

HISTORY

A two-weeks history methods institute was held immediately preceding the opening of classes last fall. This permitted senior history majors to attend, as well as the cooperating teachers of St. Louis and St. Louis County, who would have them under their direct supervision for six weeks apprentice teaching immediately following the institute.

Dr. Richard B. Ford, instructor in history at the Carnegie Institute of Technology, was consultant and lecturer the first week. He used film, lecture, and discussion to show why the old method of teaching history as a chronicle of past events which students memorize and give back in recitation or exmaination, is being replaced by the teaching methods of interpretation. He stressed that students must be able to judge whether an author's conclusions are supported by the evidence he presents.

Sister Barbara Barbato, Conal Furay, and Fred Stopsky, all from the Webster College history faculty conducted classes the second week. Facets of teaching that are universal, whether one uses the traditional or the new approach, objectives, resources, references, criteria for selection of textbooks, lesson planning, and classroom techniques were some of the subjects pursued.

Reports from the apprentice teachers after six weeks in the field were almost universally in agreement that practical application of what they had learned at the methods institute made them not only better teachers, but better historians.

WIMSA NEWSLETTER

MAY 1967, VOL. 2, NO. 3 • WEBSTER INSTITUTE OF MATHEMATICS, SCIENCE, AND THE ARTS

WEBSTER COLLEGE'S *CHOCOLATE HOUSE*

In St. Louis, there would be no argument that 2249 Mullanphy street is in a deprived area. But what goes on there could inspire anyone interested in what should be done for pre-schoolers of low-income areas, for families with little or no family solidarity, for boys just out of detention homes – with no one to care, for the despairing, and sometimes for the desperate.

It has been only two and a half years since Mullanphy House, better known as *Chocolate House* because of its sunny brown color, was established. Sponsored by Webster College, and an outgrowth of its social science department, from the outset it has been under the supervision of Sr. Therese Delich, an instructor in that department. Nowadays, Sr. Therese commutes to the College for classes a couple of times a week, but her home is Mullanphy. She and Sr. Dennis Marie, a practical nurse, are the only nuns. Barbara Wander, a Webster College graduate, and Carole Parks, a resident advisor for the Women's Job Corps, live at the house, along with Paulette Peterson, Georgia Urban, Kathy Schraeder, and Sandra Schilling, four Webster College undergraduates who have all taken a sabbatical semester to specialize in the practical application of social science. In the past, students from other departments, and not on sabbatical, have also lived at Mullanphy while carrying full class loads, and worked wherever needed.

Besides the humanitarian aspects of Mullanphy House, which we hope to take up in a later article, the project's pre-school is one of its shining lights. Development of language abilities in children who come with almost no ability to communicate has become one of its major objectives. David Buckholdt, a candidate for a doctor's degree in sociology at Washington University, along with Mike Haider, who does much of the tabulating and graphing, has a pictorial account of progress for half a dozen children who were at the bottom of the ladder in language capabilities. Not only the growth in vocabulary itself, but voluntary response in daily situations with his peers and the teachers – eating, story-telling, dancing – how many times he initiated conversations – are all grist for the graph which charts his growth in knowledge and as a person.

The token system of awards, with a plastic token given for each new accomplishment, means that during the day, or by saving up for several days, he has token money to spend for things he wants: snacks, or perhaps even better, something from the store – a typical dime store set up with the kind of toys that he would buy in a real store with real money. These he can take home.

Besides the College undergraduate teachers at the pre-school, Mary Jane Phillips, one of the mothers in the area has helped at the pre-school for the past year. She has a special gift for eliciting love and cooperation from the most recalcitrant of children.

Effort is made to interest parents – a mother's club once a week – with a chance for them to take part while seeing what goes on during Johnny's day away from home. A newsletter, *Tidbits from the Chocolate House*, goes out each week, and is a means of reaching parents who work or who hitherto have shown no interest other than to see that Johnny is out of the house and at Mullanphy. Concrete evidence that the newsletter is read is the day that a mother appears at school following mention of how Johnny helped younger ones get into their outside clothes, or that Johnny was the "Child of the Week" and had received special mention in the newsletter.

During the past year, the pre-school has operated under a grant from CMREL (Central Midwestern Regional Educational Laboratory), which was made to Dr. Donald Bushell of Webster College's social science staff and Dr. Robert L. Hamblin of the sociology department of Washington University. This has made possible the purchase of

The door to "Chocolate House" is always open

Kindergartners learn names of colors

needed teaching equipment including tape recorders, language masters (which permit the child to hear his own voice and pronunciation), the token-earned snacks, and the store's incentive-stimulating toys, think of it – a *pink plush rabbit* – all of which add to a step forward in a neighborhood where success is a mighty scarce commodity.

SPACE REVISITED

First results of a WIMSA-sponsored 5-day "People and Space" workshop with Webster College's art department conducted by Karl Linn, resource planning consultant, became evident even before he had time to leave the campus. Following a tour of the campus with interested students, with the purpose of determining its environmental shortcomings, a project to change the uninspired decor of the Co-Rec (recreation) room and its adjoining "Ivy" lounge was merely a matter of turning loose some of the talent and ideas that apparently needed only the word "GO" to burst into full bloom.

Lighting of the Co-Rec room is via three double lines of 24-inch-square light panels of frosted glass. Interest and individuality were added by inside painting of each square with varied and colorful designs and occasional pungent phrases by members of Jana Patton's Three-Dimensional Design class and other interested persons. The adjoining lounge, where students or faculty relax during coffee breaks, heretofore with pale greenish-yellow walls, was given a black ceiling to lower its height, gold pillars, burlap-covered walls, and a tasseled fuchsia center canopy.

Registered as a landscape architect in New York, Mr. Linn has held positions as assistant professor of Landscape Architecture at the University of Pennsylvania, and of Environmental Design at Long Island University. He was previously a member of the "Vest Pocket Program" for urban development, a non-profit organization composed of volunteer professionals. Currently Mr. Linn is a consultant on urban planning for the city of Philadelphia.

As with the *Show and Tell* workshop held earlier this year, the workshop endeavored to expose the total school to the problems which can no longer be isolated in one department. Mr. Linn used lectures and slides to encourage the student body to appraise its total college environment with a critical eye to its possibilities. Suggested changes discussed during his stay were a more flexible room arrangement in Maria Hall (a dormitory), parks in front of the music building and the chapel court, and the possible conversion of the old tennis courts into a basketball court or patio area. Art students would like a tree house that would connect with the roofs of the studios, a bridge to overpass Big Bend boulevard (which cuts the campus in two), – this with the aid of Washington University engineering students – and sandstone sculpture on the retaining walls of Edgar Road, which runs along one side of the fine arts campus.

Jana Patton's class in Structural Design will continue the efforts to improve the campus environment and make it more reflective of the Webster College image.

Since Linn's visit, at the request of Miller Newton, Executive Director of Mid-city Community, an inner-city improvement association, students have redecorated Newton's formerly drab headquarters with lively designs and colors, and will do the same for the Social Science quarters of the College, when approval and the budget permit.

Co-Rec room ceiling gets a new look

Meeting with Newton and an "inner city" block group, Mr. Linn also helped plan for a Neighborhood Commons on land which is now only vacant lots, many of them unsightly. The St. Louis Beautification Commission will help in obtaining the lots for the project, and the city of St. Louis will underwrite the cost of insurance and rent of the lots from the owners. Neighborhood residents will plan and build the parks, and if Mr. Linn's suggestions are followed, will start by building benches, tables, and sandboxes, then additional recreation equipment for children. He suggested use of cast-off materials such as telephone poles, cable spools, oil drums, railroad ties, bricks, etc. Residents of the area will also be responsible for upkeep and supervision of the parks, once they are built.

Summer will find art director Jana Patton, along with Terry Barrett, John Traversa, and possibly other Webster undergraduates moving to quarters in the mid-city area to lend what help and inspiration they can to get the Neighborhood Commons out of the planning stage. It will be an interesting project to watch.

TAKE-OFF IN SPACE

In what might be considered a sequel to her unit on *LINE* (WIMSA Newsletter, December '66), Sr. James Anthony Udovick, director of music in the College's Experimental School, gave the element of *SPACE* some of the same treatment with very gratifying results.

Some of the concepts of the term *space* that various members of her class contributed were: the space occupied by the astronaughts; the part of the floor occupied by nobody and no thing; the space *between* things; a vacuum; the space between lines on the musical staff.

Following a study of pictures spread out on the floor, space was discussed from the viewpoint of what objects were occupying space and what *ideas* of space the pictures suggested. After injecting the idea of *positive* space, dominant objects in the pictures, and *negative* space, the background, the conclusion was reached that music also uses these contrasting elements – with the positive space being the main theme, the solo instrument, or the melody line, and the negative space the background music that lends contrast or beauty to the main instrument. Records were listened to and analyzed with this in mind.

The class studied space on the musical staff and discussed music in the various major and minor modes. They then moved on to consider the scale as high, middle, and lower space. Using the scale *do-re-mi-fa-sol-la-ti-do* as *1-2-3-4-5-6-7-8*, the class worked in three sections, one using the upper tetrachord *5-6-7-8* only, the next using the middle section *3-4-5*, and the third the pentachord, *1-2-4-3-5*, to compose melodies of four measures in 4/4 time. The three sets of measures were then tried in various combinations – top to bottom, bottom to top, middle to top, middle to bottom – to determine the desired sequence they wanted. Since one set of four measures ended on *do*, it was chosen as the last line, because the other two lines left one with the feeling that the melody was unfinished. Going one step farther, the class decided to have each group sing its line at the same time, and they were delighted to find that the different units combined harmoniously. Next they played it on instruments, in different keys, reading it from their own staff. The knowledge gained in staff reading time signatures, keys, tonal centers, and chordal arrangements was all a part of the fun of composing music together. How much was learned was put to a test later when individual members of the class composed melodies, choosing their key, and transferring it to the instrument of their choice.

THE *NEW* ART

First grade art, when it is under the supervision of Webster College's Jana Patton, isn't just a matter of crayons or paper and pencil. These youngsters have made a study of line and learned that it has direction, and that it divides things. They have looked for lines outside in nature, and will soon be dividing their classroom into spaces by using string, and building themselves play spaces of corrugated boxes.

At present, following a short discussion, each child is drawing and painting an island on which he will theoretically have to spend the rest of his life, and he must decide what he will want and need there. Most of them thought of a house pretty quickly. It was a while before many of them thought of food. One of the first things that one of the boys painted on his island was a *girl-eating bush!* More practical perhaps were those who carefully sectioned off garden plots, drew fruit trees (one was a combined apple-coconut), cows, tractors, tackle-box and fishing rod. Several of the girls added flower beds, two of the boys – machine-guns surrounding the entire coastline, with one boy adding a computer. Several started coloring and painting trees, people, etc. on separate cardboard to place upright on their islands, making a third dimension. Spelling, by those who used it, seemed remarkable, with never a word misspelled – ocean, children, people, school, garden.

Jana and her two undergraduate student teachers roam the room giving encouragement and asking questions that provoke additional thought and consequent action. Overheard, was:

"What are you going to eat on your island?"

"There'll be palm trees so that I can have coconuts and bananas." Gleefully, from the boy to his left, "You can be a monkey!"

"Why do you want all those machine-guns?"

"So if the enemy comes, like Germans, I could shoot them."

"*I'm* German, would you shoot me?"

"No, you're half American."

"You just might shoot someone you didn't intend to!"

Little Erika, busily cutting out just-painted little girls, "I can't really make people very well."

"But your colors are lovely."

"Thank you." (Pause) "But you know what?" and now cutting happily, "*Nobody's* perfect, – except God."

FUTURE TEACHERS MEET AT COLLEGE

Two WIMSA participants appeared on the program of Webster College's annual College Day for Future Teachers of America when it convened at the Loretto-Hilton Center for the Performing Arts early in April. Sr. James Anthony Udovick, music director of the College Experimental School, involved some of the sixth grade students as well as a number of the members of the audience during her demonstration of elements involved in the understanding of music and rhythm. Among these she lists rhythm, speech, dance, body instruments (as finger snapping, knee slapping, known in German as *pachen*), percussion instruments, singing, theory, creative writing, music appreciation. Working with four rhythms, she taught the audience to do them first in unison, then canon style, to the accompaniment of a record. Next a number of instruments – xylophone, tambourine, maracas, cymbal, claves, were used, and finally words which were suggested by the audience were added: "Hi there", "We are glad to SEE YOU", "You LOOK so HAP-PY", and "GOOD-BY now" – all accompanied by clapping, stamping, finger snapping, knee slapping, hand motions, or a combination of these. During one of the series of rhythms, Kathy Williams, one of the College School pupils, improvised a dance.

Perhaps it should be said that Sr. James Anthony's elementary school classes learn to identify various types of music by their style, and have the experience of writing music of their own in which these rhythms are used and put to movement. (See *Take-off in Space*, this issue.)

Robert Strobridge, assistant professor of the College's department of art, gave a slide-illustrated talk to demonstrate how our culture is changing from the older generation's don't-interrupt-my-train-of-thought habit to that of the younger generation's invitation to diversion by doing three or four things at once. Strobridge theorized that Bobby Dylan purposely sings in the tones he does so that his audience, unable to *stand* the sound, concentrates instead on the words; as with – "Mothers and fathers throughout the land, don't criticize what you can't understand" – he thus puts over his message. From the applause following Strobridge's imitation of Dylan singing, the concensus seemed to be that he could run Dylan a close second.

Continuing, Strobridge pointed out that we never see anything in isolation – only in relationship to its environment, and *that* – colored by our own reaction to it. His statement that a human characteristic is always to want *closure* was well-documented by slides showing unfinished geometric shapes which surely all present found themselves terming squares, triangles, or by other geometric names – and a final slide from Michelangelo's painting of "The Creation" in the Sistine Chapel, showing the hands of God and newly created man *almost* touching.

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The two packages are:

- *The Shell Game* (subject matter)
- *Focusing on Time* (film)
- *In Search of Congruence* (commentary)
- *On the Fly* (subject matter)
- *A Linear Look at the Fly* (film)
- *The Fly Cycle* (commentary)

See "Write WIMSA for:" for prices and further description of content.

Photos, in order of appearance, by Barbara Wander, Washington University, and Tom Linehan.

Write to WIMSA for:

New since last issue: *Even Flies Remember* by Paul Merrick. Some suggestions for heredity experiments with the house fly. One copy free. Additional copies .25. Film, *Building Genetic Models,* (55 min.) available on a limited basis on same terms as above-mentioned films.

Ready by fall: Sample units of *Campus School of Religion* curriculum. No charge.

New scheduling of art exhibit, *The Image in Our Electronic Age.* (Write for description) Terms: $25.00 rental plus shipping charges one way.

An Experimental Teacher Training Model in Science, *The Shell Game,* a 28-page experience in estimation and measurement. One copy free, additional copies .20.

Focusing on Time, a classroom film featuring children working through the first lesson of *The Shell Game.* $5.00 rental covers handling charges, insurance both ways, and one week's use following receipt of film.

In Search of Congruence, a teacher commentary on the film *Focusing on Time.* Mailed free with all requests for *The Shell Game* or the film.

On the Fly, first of a series of documents dealing with the biology of the house fly. One copy free, additional copies .15.

A Linear Look at the Fly, a classroom film of a terminal lesson following five weeks of working with experimental materials on the house fly. Film is now being used experimentally by selected schools. Available on a limited basis on the same terms as *Focusing on Time,* above.

The Fly Cycle, a teacher commentary on the film, *Linear Look at the Fly.* One copy free, additional copies .05 each.

Teaching Units in Mimeograph Form:

WIMSA Music Program: *Rhythm* unit, *Western* unit, *Indian* unit. No charge.

WIMSA History Program: *Project Ancient History,* a 25-page aid to teachers. No charge.

WIMSA, the Webster Institute of Mathematics, Science, and the Arts, is a vehicle by which experimentation and innovation begun at Webster College can be enriched and continued. It encourages the exchange of ideas and cooperative action among researchers on all educational levels. The Institute, funded by private foundations and federal grants, aids curriculum innovators in the production of materials, the communication of new teaching methods, and the pre-service education of teachers.

The WIMSA Newsletter is published several times a year to exchange information and ideas. We welcome suggestions that will make this Newsletter more useful. If you wish to be placed on the Newsletter mailing list, please write WIMSA, Webster College, St. Louis, Mo. 63119. Adelaide Whitesitt, editor.

WIMSA Newsletter

WEBSTER INSTITUTE OF MATHEMATICS, SCIENCE, AND THE ARTS
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WIMSA NEWSLETTER

MARCH 1967, VOL. 2, NO. 2. • WEBSTER INSTITUTE OF MATHEMATICS, SCIENCE, AND THE ARTS

THE MADISON PROJECT IN ACTION

There is never a time that the Madison Project, now in its sixth year at Webster College, isn't doing something exciting and innovative in the fields of mathematics and teacher training. In the opinion of its director, Dr. Robert B. Davis, one of its newer endeavors in the field of pedagogy, "Stop-action" films, promises to play an important part in future pre-service and in-service teacher education programs. Madison Project's Louise Daffron and Jerry Glynn are working on a new version of an earlier film, originally entitled "Weights and Springs." The new version will be interrupted every minute or two for discussion, or to call attention to a point that might otherwise be overlooked. The same will be done with other classroom-teaching films as time permits.

Under the auspices of the USOE Implementation Project, the Madison Project has been able to affect curriculum and improve pedagogy through lectures, institutes, and what Dr. Davis calls "Peace Corps" type of help. More than eighty hours of classroom teaching by teaching experts is on film and available through the Project. If a teacher shows exceptional ability in mathematics *and* teaching, and Dr. Davis learns of it, it goes on film. An instance of this is Kathy Vaughn, of St. Louis's Banneker District, teaching the principles of Cartesian coordinates to second graders. Other outstanding work in this urban poverty area has previously been done by Knowles Dougherty and Ogie Wilkerson in cooperation with the well-known educator, Dr. Samuel Shepard.

Although the USOE grant terminates next June, the Project's "Big City" program can properly be regarded as its sequel, since it builds on both people and ideas from the USOE program.

Most of the mathematics materials production of the Madison Project has been under the National Science Foundation's Course Content Improvement Program (CCI). Besides the aforementioned films, other physical materials (sometimes referred to with tongue in cheek as the "Shoebox Program") have evolved. "Shoebox" materials are physical materials from which mathematical concepts can be derived. Each unit encourages independent or small-group exploration of materials. At present, there are five "Shoebox" units available. Each contains materials and instructions for their use. Briefly, they are:

The Peg Game, modeled after the ancient shuttle puzzle. The narrow board has nine holes and eight pegs (four each of two different colors, placed at opposite ends). The game is to interchange the two colors by jumping no more than one peg or moving no more than one space at a time. A "truth table" which the child keeps, records the least number of moves necessary to move varying numbers of pegs to the opposite end of the board, and finally yields a mathematical equation which represents the least number of moves for any given number of pegs.

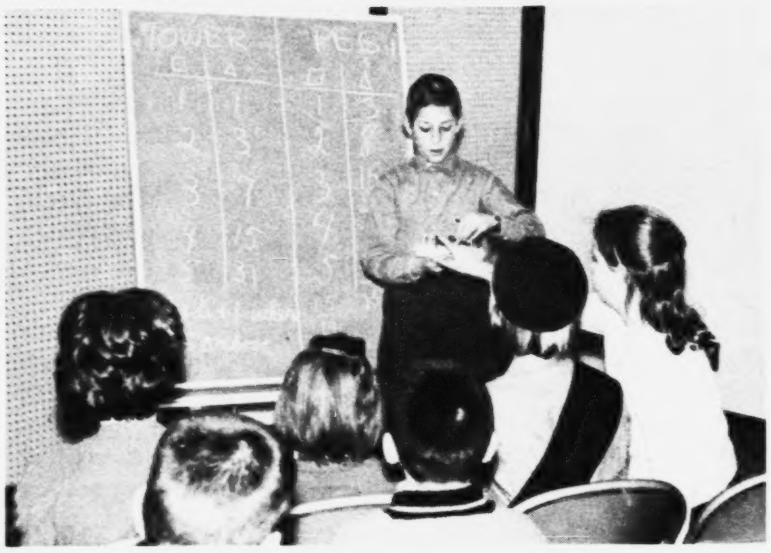
Disc Shoebox. This contains a series of five wooden circular discs of varying diameters, which teaches the relationship between the diameter and the circumference of circular objects. Circumferences are measured with a string which is then measured on a ruler and comparisons made.

Centimeter Block Shoebox. Using *cuisinaire* rods, the student determines the exposed surface area, first exposed in entirety, then when arranged in different patterns.

Geoboard Shoebox (Geometry board). This board has 25 round-headed nails in evenly-spaced rows of five each. The child uses rubber bands of varying sizes to make basic geometric shapes, and is then able to figure and compare areas. These shapes can also be cut from construction paper so that it is possible to place one shape upon another.

Tower Puzzle Shoebox. This is a board with three posts in a row and a stack of six or seven discs graduated from large to small on the center post. The object of the

Pupils in Bellevue, Washington work out "truth table"



Chicago class studies geoboards with Dr. Davis

St. Louis's Jefferson School boys collaborate on Peg Game

game is to move all the discs from the center post, moving only one disc at a time, and always placing a smaller over a larger.

Persons interested in more information about the "Shoebox" games or the classroom-teaching films, can write directly to: Webster College Madison Project, 8356 Big Bend Blvd., St. Louis, Mo. 63119.

The Project's "Big City" program referred to above, is funded by the National Science Foundation's Cooperative College-School Science program (CCSS). It is a joint effort in teacher education between Webster College and the schools of New York City, Philadelphia, Chicago, Los Angeles, and San Diego County. Briefly, its goal is to make mathematics classes more enjoyable for both teachers and students, to encourage a creative approach, and to create the means whereby the traditionally static curriculum can begin to grow and evolve from one year to the next.

An intensive two-week workshop to be held at the Byrd School in Chicago this summer will be taught by 40 Madison Project specialist teachers, at primary, intermediate, and upper grade levels. The four-floor Byrd School is remarkably well equipped to take care of the workshop, with its own closed-circuit TV system, multiple sets in every room for viewer convenience, and three separate TV channels which can operate simultaneously on the first floor. This workshop will be one more opportunity for participating in-service teachers to learn how to cast the student in the role of experimenter or innovator or decision maker, to increase the vitality and relevance of his experiences with mathematics, and thereby to increase his sense of commitment to school and to intellectual matters in general.

COLLEGE HAS A ROSETTA STONE

WIMSA was the recipient of a most interesting gift this year, when Prof. Hyman Kavett of the department of social science of the Jersey City State College, sent a Rosetta stone replica as a "Thank you" for having received a copy of Sr. Barbara Ann Barbato's bibliography, "Project Ancient History." Prepared by Alva Museum Replicas, Inc., 140 West 22nd St., New York, the unit consists of the replica, a teacher's guide, and activity sheets for students. It includes a bibliography of books on history, archaeology, and ancient life in Egypt, which opens innumerable related avenues of study. History major, Ann Garrity, made use of it in a fifth grade social studies class in Webster College's Experimental School, and had the following to say about her project:

The class had been studying European countries before the Rosetta stone was brought in, and had used several media in summarizing their work. Without using the prepared plan directly, I incorporated some of its ideas into a unit of my own on "writing." The class developed its own system of writing which progressed from "thing pictures" and "idea pictures" to "sound pictures." They then observed a similar development of writing on the Rosetta stone. Pictures of objects and ideas were obvious in Egyptian hieroglyphics, an old form of picture-writing dating back to the later part of the fourth millenium B.C. "Sound pictures" began to be incorporated into demotic script, a simplified form of hieroglyphic writing which made its appearance about the middle of the first millenium B.C. Finally, using the third part of the stone, the class made a comparison of the Egyptian, Greek, and English alphabets.

They explored how a writing system works as a means of communication. They were interested in seeing how some of our alphabet evolved from picture-writing, and how Thomas Young, an Englishman, and later the French archaeologist, Jean Francois Champollion, deciphered the hieroglyphic forms on the Rosetta stone.

Some day, perhaps some of them will be fortunate enough to visit the British Museum in London, and see the original Rosetta stone. Knowing its exciting history – discovered by French engineers during Napoleon's Egyptian campaign in 1799, surrendered by France following Napoleon's defeat by the British in 1801 – and unfolding the secret of Egyptian writing which had been lost for 1300 years – the stone, for them, will surely hold more meaning than to the average beholder.

EDUCATOR VISITS WEBSTER CAMPUS

"Where are we trying to get – and is this thing we are doing helping us to get there?" is one of the questions teacher-author John Holt poses in his book, "How Children Fail." Those who heard him speak when he was on the Webster College campus the weekend of December 10 as consultant and speaker for *Upward Bound* and at a meeting of *WIMSA* participants on Sunday afternoon, found him both provocative and inspirational, and are looking forward with interest to the publication of his new book, "How Children Learn," which is now ready for the press.

Dr. Holt visited the College's Experimental School while here, and said, "I was impressed by how relaxed and natural these children seem to be." Of the building itself, "The main building seems to me about the best elementary school building I have yet seen, – handsome, functional, and economical. There seems to be a lot of architectural showing-off in school building these days, so I am warmly prejudiced in favor of a building that provides a maximum amount of useable space at minimum cost. Nobody with any sense argues about the merits of carpeted floors for elementary schools any more, but there is the problem of selling it to voters, etc. For this purpose, I suggest calling it Low Maintenance Flooring."

Dr. Holt feels that, "We must explore and develop ways to make the school more and more a place for independent and self-directed study, even for very young children. In this connection, I am not sure at all that what schools need is fewer and bigger spaces; it may well be that they need more small spaces, where single children or small groups of children can work."

More quotes from "How Children Fail" may be worthwhile for those who haven't yet become familiar with the John Holt philosophy.

". . . really able thinkers . . . turn out to be without exception, the children who don't feel the need to please grownups."

"We ought to learn, beginning early, that we don't always succeed."

"The true test of intelligence is not how much we know how to do, but how we behave when we don't know what to do."

Of the progressive school – ". . . does its best not to put pressure on little children . . . does not give marks in the lower grades . . . tries to keep children from feeling that they are in some kind of race."

SHOW AND TELL

Children love to "show and tell" – so why not adults?

Webster College's *Show and Tell,* held at the Loretto-Hilton Center for the Performing Arts on December 5-6, started with an idea of art teacher Jana Patton's. It was later expanded during what could be called a brainstorming session of Webster art department personnel, at which time it was decided to bring in Myron Kozman of the Layton School of Art, Milwaukee, to supervise.

From the beginning, the idea was to involve as many departments of the college as possible in an exchange of ideas in a theater environment, through the use of sound, light, movement, color, and projection. A month went into its preparation, with Jana's classes in structural design and the Loretto-Hilton's expert technicians cooperating with students and faculty from the College's English, history, music, dance, philosophy, drama, science, and art departments.

With Kozman on hand as consultant and director, *Show and Tell's* diverse segments were variously described as fascinating, startling, thought-provoking, beautiful, unusual, and "I don't get it!"

The physics department contributed a laser which the dance department utilized to choreograph a dance which followed the red dot of the beam as it moved to various parts of the stage.

Stunning transparencies resembling impressionistic paintings were shown on multiple screens to the accompaniment of electronic music. What were they? Chemical reactions of such household products as Clorox, hair spray, spray deodorant, spray glue – that art major Pam Linehan had put together on clear plastic.

The philosophy department gave a melodramatization of Victorian morality with philosophy instructor Andrew Bjelland reading "Stories from Aunt Margaret" – "*Better be good* or –," "*Better love Jesus* or –," to a student accompaniment on the autoharp.

Ralph Gardner, a retired clergyman of Stapleford, England made an interesting contribution. One of his hobbies since retiring is recording English and American poetry with music of a contrasting mood as background; for instance, Shakespeare with jazz. Two girls from Barbara Folk's Introduction to Literature class, who are also exponents of the dance, Connie Hiller and Cam McHale, gave a dance interpretation of E. E. Cummings' "The Mouse," with the Reverend Gardner reading the poem and Stravinski music as its background.

A number of times the *Show and Tell* audience found itself involved either on the stage or in their seats. In an on-the-spot improvisation, second graders of the College's Experimental School were called to the stage, and working under the direction of dance instructor Judy Mandeville, did a "Let's see what we can do on the stage" sequence. One was to see if they could get on and off the stage without making a sound. (This took a little practice.) Another was a variation of the child's game of "Statue" – when they froze in place at her command, "Stop!"

Sr. Gabriel Mary, Webster's art department chairman, hasn't said, but many of those who saw *Show and Tell* are hoping that it is only the first of what should become an annual affair.

Dr. Holt, Director David Roach, teacher Mary Hartley

Second graders on stage at "Show and Tell"

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CURRICULUM INNOVATION IN SCIENCE

by Paul D. Merrick

During the past three years a multi-level curriculum development structure has evolved in the "S" area of WIMSA. Our first publication, *The Shell Game,* was a straightforward curriculum development effort to provide "do" oriented science materials for use in the intermediate grades of the elementary school. In a sense, *The Shell Game* lived its entire developmental life in the fourth and fifth grade classrooms of Webster College's Experimental School. It neither took account of the teachers who would teach it nor of the college environment which surrounds the elementary school.

The making of the classroom film *Focusing on Time* turned out to be a milestone. Almost from the first showing, we realized that it had much greater mileage as an instrument for general use in teacher training than as a specific aid to help teachers utilize *The Shell Game* in their classrooms. This insight led to the development of "model" packages for use in teacher training. The first of these consisted of a subject matter theme, *The Shell Game;* the classroom film, *Focusing on Time;* and a commentary on the central ideas of the filmed lesson, *In Search of Congruence.*

Science curriculum materials for the elementary school published and under development in 1965-66 were the result of "the total college environment" rather than the Experimental School in isolation. *On the Fly* grew out of experiences with laboratory-centered activities – *The Continuous Laboratory Block* being developed in a college freshman biology class and the Webster Master of Arts in Teaching (MAT) program. The actual trial teaching of *On the Fly* in the Experimental School was carried out by five Webster students, all of whom had taken the college course. Because of this integrated approach, *On the Fly* is a basically different kind of curriculum resource than is *The Shell Game.*

Even Flies Remember, an experience in heredity, goes a step further in the evolutionary process. It is intended primarily for teacher training, although it contains materials which were developed with children and are suitable for the intermediate level grades. The trial teaching of *Even Flies Remember* was completed in the spring of 1966, but much of the laboratory work for background materials is still in progress. We have delayed publishing this document until the spring of 1967 so that it could be correlated with the teaching of our regular college Genetics course.

There is one other facet of the curriculum development structure at WIMSA which deserves more than casual mention. One of the five students who did the trial teaching of *On the Fly,* Mrs. Helen Eckelkamp, elected to do a research problem related to *Even Flies Remember.* Her research problem, which is concerned with the migration tendencies of house fly maggots, grew out of her experiences with the preparation of materials for the classroom teaching film, *A Linear Look at the Fly,* which was filmed in the studios of KMOX-TV, St. Louis. Her research efforts will have a marked influence on the content and emphasis of *Even Flies Remember.*

Colleges and universities have the potential of providing a unique climate for the development of curriculum materials. Webster College has pioneered a pathway which should have alternative routes in a dozen or more institutions of higher learning. Curriculum development in isolation from any of its essential component parts – children, school, teacher, university, and specialist, is apt to produce something which falls short of the quality necessary for the long-term improvement of science education in the elementary school.

THE SOUNDS I SAW

Have you ever seen a sound? Students in Robert Strobridge's sixth and seventh grade art classes have tried it.

The project started with a listening session of tape recordings of advertisements Strobridge had made from television programs in a 40-minute period by switching quickly from channel to channel. Isolated, it was surprising how many sounds there were that seemingly had no relationship to the product being advertised.

The second step was listening to sound tape and telling what they "saw" when they heard a particular sound. One sound brought these varied responses: an electrical storm; a lighthouse with waves washing; a big wind – trees without leaves; a baseball game with the dugouts half-filled with water. Upon being questioned, it was found that each student had associated the sound with a particular experience of his own.

Bob Schnorf of KMOX-TV discusses filming with Merrick

Strobridge's class has "Sounds" workshop

New words evolve from old sounds

Assignment for the next day was to bring whatever was necessary to class to make six different sounds, none of which would use the human voice. Considerable imagination was shown, one might say especially by those who forgot to bring any props. Turns were taken in operating the tape recorder as each member identified himself then made his six sounds without further comment. Here are some of the sounds recorded for the purpose of later making up entirely new names for them: finger snapping; rubbing hands together; opening and closing a window; pounding the table with a belt buckle; snapping heels together; crumpling paper; opening and closing a ring-binder notebook; using a paper punch; unwinding masking tape; a gong; ticking of a watch; snapping a coin purse open and shut; cutting and crumpling aluminum foil. After a session like this, small and usually unnoticed sounds suddenly become noticeable.

Before the naming session the class made an analysis of letter forms and the modifications that could be made in letters to make them express different qualities – weakness, strength; boldness, delicacy; as well as building patterns out of letter rhythm forms through modification.

The morning that new sound names were invented brought forth such descriptive "words" as gerked, shov, gruth, swigaly, gogoq, saj – with the following names being given one sound, the gong: ooli, Ju-u-u, spaayyy, sweeval. (Note how each contains double vowels in recognition of the gong's resonance.)

If one of Bob Strobridge's objectives in this class is a quickening of the senses, it would appear that he is on the right track.

ST. PAUL, A MAN OF CONFLICT

A unit on St. Paul and conflict situations as taken from the Book of Acts has exposed seventh graders of various faiths to some thought-provoking ideas.

The project, as carried out in the Campus School of Religion by Sr. Anna Barbara Brady of the College's theology department and Fred Stopsky of the history department, had its inception in a discussion with the seventh grade on how historians work. At this time the subject of conflict came up. It is hoped that through a study of conflict and the way basic human problems have been solved in the past, the class will be better able to analyze personal or group problems that they encounter.

The first step in the development of this unit was an analysis of a list of "facts" to determine whether or not they were indeed fact or opinion. Among these were such statements as; "The Mississippi is the most beautiful river in the world," "The President of the United States is Lyndon B. Johnson," "Humans prefer freedom to slavery," "World War II began in 1939," "All men are born equal." Study of these brought the realization that while some things are incontrovertibly true, in other cases what might be true for one person is not necessarily true for another.

Before beginning the actual study of conflicts as depicted in the Book of Acts, Mr. Stopsky called attention to the fact that historical events are described from the viewpoint of the writer. In scripture the viewpoint is one of faith, and the Bible is written from the viewpoint of Christians. One girl in the class related the conflict with Jewish traditions which St. Paul encountered to the changes taking place in the church today. Religious leaders are again challenging traditional religious views. Further discussion pointed up similarities to the present day fight against communism.

To give a better background for analysis, there was discussion of the kind of drives which prompt humans to act (physical, cultural, social), often to the point of going to battle for something.

Illustrative of the conflicts chosen for study is Acts 14: 18-19. "But some Jews arrived from Antioch and Iconium, and after winning over the crowds, they stoned Paul and dragged him outside the city, thinking he was dead. But the disciples gathered round him and he got up and re-entered the city." Other verses of the Bible covering the same incident were given for further reading.

The class was given the following outline with which to analyze conflict situations (their own as well as those of St. Paul), much as a doctor analyzes a disease:

Title
Situation of conflict
History of the situation
Diagnosis (symptoms, causes, hypotheses)
Treatment (and other possible treatments)
General principles which can be drawn from this conflict situation

Through these studies, the class has been encouraged to try to see the reason for divergent points of view, and through an understanding of human relationships, to be able to meet life situations of their own with a little more objectivity.

With the study project still in process, Sr. Anna Barbara has divided the class into four groups, each working with a conflict situation in four different biblical cities, and producing a newspaper of the times with news articles, feature stories, editorials (from two differing points of view), and advertisements.

The human value of objectively viewing conflict situations is immediately obvious. At the same time the students have, almost in spite of themselves, learned a great deal about St. Paul, about the Book of Acts, about the attitudes and faith of the early Christian community. If they have gained some new insight into what it means to be a follower of Christ, they have found the new insight for themselves, growing out of a living experience, rather than interpreted for them by another.

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Write to WIMSA for:

An Experimental Teacher Training Model in Science, *The Shell Game*, a 28-page experience in estimation and measurement. One copy free, additional copies .20.

Focusing on Time, a classroom film featuring children working through the first lesson of *The Shell Game.* $5.00 rental covers handling charges, insurance both ways, and one week's use following receipt of film.

In Search of Congruence, a teacher commentary on the film *Focusing on Time*. Mailed free with all requests for *The Shell Game* or the film.

On the Fly, first of a series of documents dealing with the biology of the house fly. One copy free, additional copies .15.

A Linear Look at the Fly, a classroom film of a terminal lesson following five weeks of working with experimental materials on the house fly. Film is now being used experimentally by selected schools. Available on a limited basis on the same terms as *Focusing on Time*, above.

The Fly Cycle, a teacher commentary on the film, *Linear Look at the Fly*. One copy free, additional copies .15 each.

Teaching Units in Mimeograph Form:

WIMSA Music Program: *Rhythm* unit, *Western* unit, *Indian* unit. No charge.

WIMSA History Program: *Project Ancient History*, a 25-page aid to teachers. No charge.

Photos: pages 1, 2, by Madison Project; Holt and "Sounds" pictures, Brian Matheny; Schnorf and Merrick, Jim Middleton; "Show and Tell," Tom Linehan.

Please, when you send us a CHANGE OF ADDRESS, send your *old* as well as the new address. New postal regulations make it necessary for us to file by zip code, state, city, then name – so when you move, unless you give the old address, it is virtually impossible for us to find your old plate to discard before making your new one.

WIMSA, the Webster Institute of Mathematics, Science, and the Arts, is a vehicle by which experimentation and innovation begun at Webster College can be enriched and continued. It encourages the exchange of ideas and co-operative action among researchers on all educational levels. The Institute, funded by private foundations and federal grants, aids curriculum innovators in the production of materials, the communication of new teaching methods, and the pre-service education of teachers.

The WIMSA Newsletter is published several times a year to exchange information and ideas. We welcome suggestions that will make this Newsletter more useful. If you wish to be placed on the Newsletter mailing list, please write WIMSA, Webster College, St. Louis, Mo. 63119. Adelaide Whitesitt, editor.

WIMSA NEWSLETTER

DECEMBER 1966, VOL. 2, NO. 1. • WEBSTER INSTITUTE OF MATHEMATICS, SCIENCE, AND THE ARTS

MAKING HISTORY MEANINGFUL

Webster College changed its college calendar this past summer so that a two-weeks history methods institute could precede the opening of regular fall classes. This permitted senior history majors to attend, as well as the cooperating teachers of St. Louis and St. Louis county who would have them under their direct supervision for six-weeks apprentice teaching immediately following the institute.

Dr. Richard B. Ford, instructor in history at the Carnegie Institute of Technology, was consultant and lecturer the first week. Plans for his participation were made by Sr. Mary Mangan, history department chairman, with the cooperation of Sr. Barbara Barbato who had attended an NEA institute directed by Dr. Ford at Carnegie Tech.

During his week here, Dr. Ford used film, lecture, and discussion to show why the old method of teaching history as a chronicle of past events which students memorize and give back in recitation or examination, is being replaced by the teaching methods of interpretation. He stressed that students must be able to judge whether an author's conclusions are supported by the evidence he presents. They must also learn to come to conclusions of their own and to present the evidence on which these conclusions are based. He made it plain that inductive teaching requires the teacher to be a questioner and guide rather than an expounder.

Several students presented ten to fifteen minute history lessons, which were immediately analyzed for objectives and use of materials and strategies of the new social studies methods.

Local guest speakers also took part in the institute. T. R. Tomlinson, head of the social studies department of Horton Watkins high school, showed how to use teaching materials of the new social studies, many of which were originated by Dr. Edwin Fenton, professor of history at Carnegie. Experimental units were cited from *Comparative Political Systems: An Inductive Approach,* and *A New History of the United States: An Inductive Approach.* Frank Armstrong, from the history faculty of Clayton high school, who had attended the NEA institute and had helped formulate plans for the one held here, showed how important it is to ask the right kind of questions in the inquiry approach.

Apprentice teachers report to Sr. Barbara

Sr. Barbara, Conal Furay, who directed the institute, and Fred Stopsky, all from the Webster College history staff, conducted classes the second week. Facets of teaching that are universal, whether one uses the traditional or the new approach, objectives, resources, references, criteria for selection of textbooks, lesson planning, and classroom techniques were some of the subjects pursued. Sister Barbara gave a traditional history lesson on the Reconstruction Period, and Mr. Stopsky showed how it might be changed into one using the inquiry approach. Mr. Stopsky also explained the dynamics of school operation, the role of the principal and the superintendent, possible inter-faculty problems, and discipline in its various phases which might even involve parents as well as students.

Reports from the apprentice teachers after six weeks in the field were almost universally in agreement that practical application of what they learned at the methods institute made them not only better teachers, but better historians.

THE IMAGE IN OUR ELECTRONIC AGE

Even a casual observer of a recent art exhibit, *The Image in Our Electronic Age,* held at the Loretto-Hilton Center of Webster College, found graphic evidence that the world of art has moved into a new orbit. The concept which finds art confined for the most part to gravity-bound structures is being changed by the younger generation which finds art in the most unexpected places. New electronic measurements are becoming source material for image making. Microscopic studies show patterns of nature formerly interpreted only by the scientist. Magnetic fields in ever changing forms appear, as carbon dust on paper responds to a magnet passed beneath it. Photography captures the intricate design of a snake skin — or a transient process in a chemical reaction.

Robert Strobridge of the Webster College art department, says, "Teachers are more and more removing themselves as the dispensing agent and becoming a part of the learning group, often finding themselves recipients of the new kinds of information which the new orientation of students brings about."

The snake skin would be a case in point. First the student found that she could project the image on a wall — then that it could be projected onto sensitive paper and thus captured in all its beauty. Subject matter is bound only by imagination, and judging from this exhibit, the imagination has no limits.

LINE UP!

Teachers who have made use of the *RHYTHM, WESTERN*, and *INDIAN* music units that Sr. James Anthony Udovick and Sr. Rose Annette Liddell originated last year, and which are still available by writing to WIMSA, will not be surprised that Sr. James Anthony of the Webster College Experimental School is at work on another original project. A thirty minute visit made on the day it was started, gave more than a small insight into its implications and possibilities. In depth, it will be a critical survey of current magazine and television advertising as it relates to art, music, and motion. The children will begin their study with melodic line. Records will be listened to in order to find whether the melodic line is smooth or pizzicato style, whether it ascends or descends, whether it is deep or high. Poetry reading will determine whether the verses are measured or free. Architectural patterns will be examined to look at the various lines of buildings, columns, roofs.

Sr. James Anthony admitted before the class arrived that, "It is going to be interesting to see what comes out of this."

In preparation for the class she had thumbtacked a sheet of paper to a bulletin board, and placed a number of colored crayons nearby. With the class of seventh and eighth grade girls seated informally on the carpeted floor, and a small blackboard for her own use (the boys would have their turn later), she was ready to begin the first lesson of the project – LINE!

Her first suggestion was, "Let's see how many kinds of lines we can think of."

They came thick and fast. Straight, zigzag, curved, spiral, thick, horizontal, jagged, diagonal, dotted, parallel, thin, wavy, spherical. As each was named, a child was asked to choose a crayon and draw that particular line on the thumbtacked paper.

"Fine! Now, let's see if we can *play* these lines on one of the musical instruments." Response was immediate and excited. Using the various xylophones, we heard – *straight* line, one single note. *Zigzag*, two single notes, alternating several times. *Parallel*, two notes played in unison. *Thick*, one heavy stroke on the bass drum. *Wavy* – several notes up and back, repeated several times.

Jag, boys, jag!

Lines make patterns

"Perhaps some of you as a group can make yourselves into these lines."

Straight was easy, as was *jagged* (an irregular back and forth line of the five students taking part.) *Spiral* might seem to present a problem, but not for long. One child got into a low stooping position. Three others circled her with knees bent so that they were at graduated heights, and the tallest girl of all stood at full height to complete the spiral. *Dotted* – what would they do with this one? It was as if they had decided beforehand – for without even going into a huddle they lined up. Perhaps the credit belongs to the first child in the line – who gave a tiny jump in place and was followed in order by each of the others. Other kinds of line followed, with the same imagination shown.

The thirty minute period was up. The assignment was made for the next day: "Find a picture from a magazine that has a very definite line in it. Be ready to put yourself into the shape of that line, and also set it to music." And thus the first step of an appreciation and knowledge of the relatedness of music, art, advertising, and poetry was taken.

How does one play a circle?

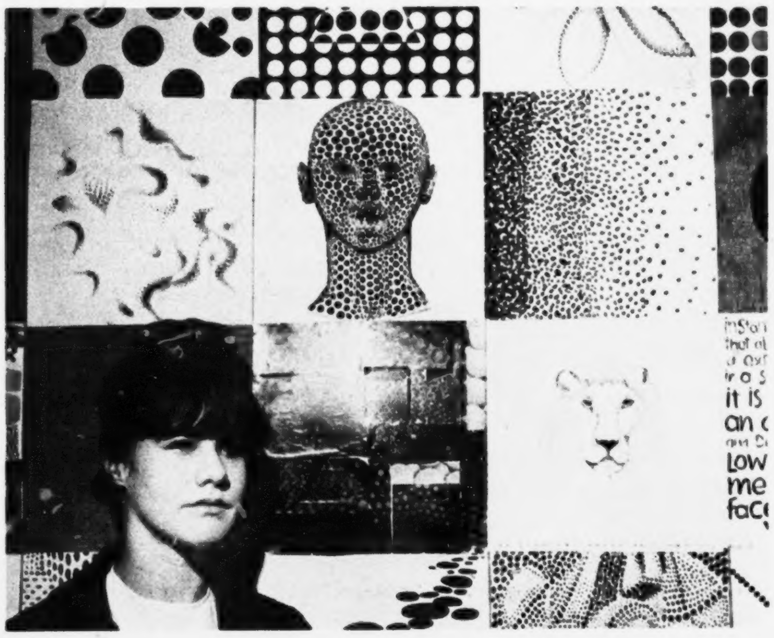
OF SPOTS AND LINES

WIMSA research in education is not confined to the classroom as visitors and students who were on the main floor of the Administration Building in November found. Walls and "els" of the main hall were taken over by WIMSA artist-teacher Jana Patton and her classes in basic design.

Jana's exposé was that, "In this particular exhibit the spot and line have been explored as visual elements of investigation and expression. The students chose quotations as verbal representations of idea relationships that occur in other ways of looking at the world: the scientific, the philosophical, the literary, etc."

"Our primary responsibility," she went on, "is to provide an atmosphere which will hopefully eliminate the preconception that 'art' is only painting and sculpture. At the same time, we attempt to equip this atmosphere with materials and experiences that will enable the student to understand that art is simply a way of looking at and communicating with the world. We try to help the student become aware that his world (or life or man) is a dynamic, growing, changing series of relationships; that an artist is anyone who actively participates in producing or creating this change and this growth."

Jana Patton before part of design classes' exhibit



WHAT IS PUPILLOMETRICS?

What is pupillometrics? It is *not* a measurement to determine the average height of the students in a given college class at Webster College. It *could* involve those students, however, if they happen to be majoring in the social sciences and are members of a class of either Dr. Carl Pitts or Dr. Ed Ernhart of the social science faculty. During the past year, partly with a WIMSA grant from the Carnegie Foundation, these two men used a number of their students as subjects in a series of experiments having to do with the constriction or dilation of the pupil of the eye as it views emotionally-loaded content.

The machine they used, invented by Dr. Eckhard Hess of the University of Chicago, photographs the pupil of the eye on a series of slides as the subject views pictures chosen for their emotional content. These can be pictures of physical mutilation, problem-solving tasks, situations of stress, persuasive communications — to name a few.

Films taken during the experiments were sent to Chicago to Dr. Hess for processing and measuring the percentage of positive (dilation) or negative (constriction) response, when compared to the base line established by use of a gray slide made prior to each stimulus picture.

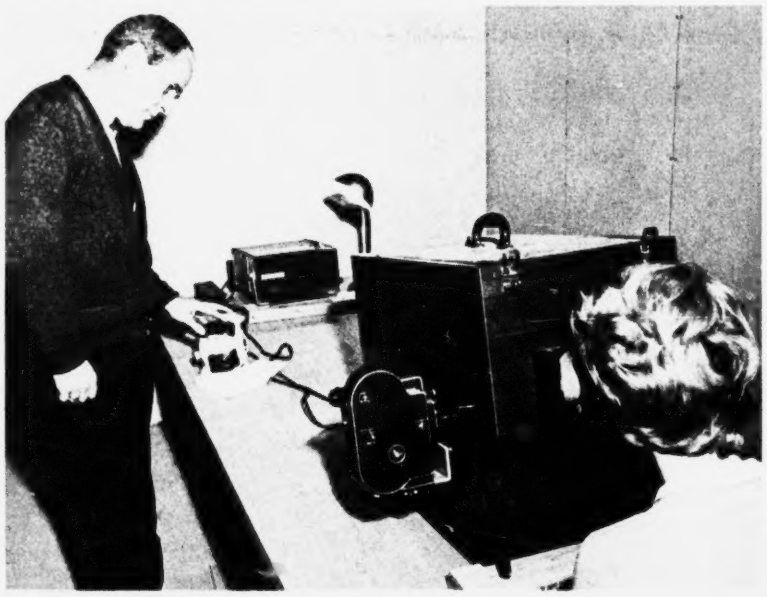
Using their findings, which Dr. Pitts termed "very provocative," he and Dr. Ernhart applied for a grant from the Central Midwestern Regional Educational Laboratory (CEMREL) which would permit them to continue and expand their studies. It was after notification that the grant had been approved that they learned of an even more sophisticated machine then being built by Dr. Larry Stark of the University of Illinois' Chicago campus. His machine uses photoelectric cells to measure intensities of reflectivity. It furnishes a constant light source on the eye, connected to an amplifier which feeds the reading from the photo-cell to an event recorder. The event recorder is a simple device with paper and a stylus which makes a graph. (Similar in principle to the making of an electrocardiogram.)

When Drs. Pitts and Ernhart visited Stark's laboratory in Chicago, they persuaded him to build them a model at the same time he was building his own. This has been done, and the Stark machine will be arriving at the social science laboratories at about the time you receive this Newsletter. Rich Robb, WIMSA technician, has been in Chicago for instruction in the care and maintenance of the machine and will supervise its installation.

The great advantage of the Stark equipment is that it can measure not just response to the visual, but to hearing, tasting, smelling, feeling — all functions over which the subject has little or no control.

After simple validation tests, such as one made with hungry subjects and those having eaten, more sophisticated ones will follow. Studies in motivation and the "need to achieve" will be made to test the efficacy of the pupillary response measure in the educative process. Hopefully, it will be possible to analyze dropouts before they reach the stage of dropping out, and take preventive measures.

Dr. Pitts tests subject on Hess machine



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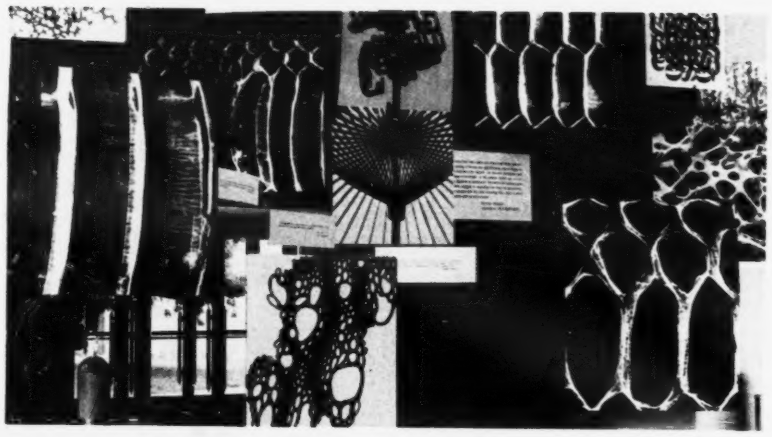

EXHIBIT NOW AVAILABLE FOR TRAVEL

The exhibit, "The Image in Our Electronic Age," is now available for display by high schools, colleges, libraries, or museums which are interested in its showing, and will pay the $25.00 rental fee and shipping charges one way. Consisting of 27 highly magnified and mounted photostats and 24 accompanying quotations, the exhibit needs approximately 100 running feet for showing to advantage. Described as, "An exhibit showing the influence of modern technology on the environment surrounding the artist as an image maker," it will be of particular interest to students of art, art teachers, and those of the general public who are interested in a part of what is going on in the minds and imaginations of our younger generation.

ZIP CODES NOW IMPERATIVE

If you do not find your zip code as a part of the mailing address on this Newsletter, we have been unable to determine what it is. This means that any subsequent Newsletters cannot be mailed to you, since starting January 1 the post office department will require first class postage for any second or third class mail that has no zip code. We want to keep you as a WIMSA Newsletter reader, so please, if your zip code is missing or incorrect, send us the correct one with your full address, and we will see that your name remains on our mail list.

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Photos pages 1, 2, 3, Brian Matheny; page 4, Al Rupp.

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WIMSA Newsletter

WEBSTER INSTITUTE OF MATHEMATICS, SCIENCE, AND THE ARTS
WEBSTER COLLEGE
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Final Report
6-1754
Project No. 661754-1-10
Contract No. OEC 3-7-061754-0196

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Curriculum Innovation in the Fields of History, Science, Music, and Art within a Single Institute

Charles F. Madden, Research Coordinator
Webster College
St. Louis, Missouri 63119

June 16, 1969

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

EA 002 579

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

Webster College

St. Louis, Missouri 63119

The Webster Institute of Mathematics, Science, and the Arts

Final Report of Expenditures
for the Period Ended May 31, 1968

	Total Budget	Expenditures to Date
Personnel	$142,636	$142,636
Consultants	5,000	6,703
Travel	5,650	1,948
Supplies	42,850	44,849
Indirect Costs	39,227	39,227
	$235,363	$235,363
Less Local Share	79,889	79,889
Federal Share	$155,474	$155,474

OE Bureau of Research No. 661754-1-10 Contract No. 3-7-061754-0196
September 1, 1967 to May 31, 1968 Date of submission: June 16, 1969

Webster College, St. Louis, Missouri 63119
Curriculum Innovation in the Fields of History, Science, Music, and
Art within a Single Institute

Project Director: Miss Jacqueline Grennan, President
Research Coordinator: Charles F. Madden, Associate Dean

I. Major Activities and Accomplishments During this Period

Introduction

This is the fourth report submitted during the period from September 1967 through May 1968 describing the activities of the Webster Institute of Mathematics, Science, and the Arts (WIMSA). These reports are on file with the United States Office of Education and provide a running commentary on the year's activities. This FINAL REPORT will review briefly the events of the months since the funding ended and provide concluding remarks on projects which were begun during the final months of the contract.

Administration

In July 1967, Charles F. Madden, Associate Dean for Curriculum and Research, was appointed by President Grennan to coordinate the research activities of those faculty members working on projects under the aegis of WIMSA. He carried this responsibility to the end of the contract and his office has continued the distribution of materials since the Federal funds were terminated.

In the six month period from June 1968 to December 1968, Mr. Madden's office answered more than 580 requests for materials developed under this contract. The requests continue and will be answered so long as the materials last. We think it unlikely that the College can afford to reprint any of these materials. Films that were produced under this contract are being circulated through the Audio-Visual Department of the Webster College Library.

At the end of the contract recipients of the WIMSA Newsletter were informed, through a form letter, of the suspension of publication. Many requests received were for additional copies of this publication. The Editor of the Newsletter and the WIMSA Administrative Assistant, Mrs. Adelaide Whitesitt, worked until the end of the contract and provided directions to Mr. Madden's office which allowed the distribution operation to continue without interruption.

Projects in Progress

Since the Interim Report of June 30, 1968 no new projects have been initiated. We continue, as mentioned above, to distribute The Four-Color Problem and Names of the Sounds I Saw, two of the final publications under the contract along with the publications issued earlier. The Image in Our Electronic Age, an exhibit created in the early stages of the Institute, returned to the campus in March and was given another exhibition in the Gallery of the Loretto-Hilton Center.

Based upon the cross-disciplinary curriculum materials developed by Thomas Linehan in the workshops for teachers, the College has contracted with Herder and Herder for the commercial publication of eight units of curriculum. The refinements, changes and additions to these materials, made since the end of the contract, remove all copyright problems but WIMSA will be credited in the publications for providing the stimulus and impetus for the work. Herder and Herder plan a Spring 1970 publication.

2. Problems

The major problem during this period has been the closing out of activities funded by the U.S. Office of Education and the absorption of costs for distribution and secretarial assistance into the ongoing budget of Webster College. Most of these have been assimilated by the office of the Associate Dean for Curriculum and Research who has had funds from private foundations--notably The Carnegie Foundation--to undergird the office operation.

Faculty members who were engaged in the development of materials have been able to fund a limited number of projects through their department budgets but the withdrawal of Federal support has meant a swift diminution of activity. An example may make this point clearer. Dr. Carl Pitts, Psychology, has, over the years of the project, had a continued interest in behavioral objectives. He has applied the Skinnerian principles of reinforcement to the presentation of various curriculum materials and has developed some highly successful patterns of instruction. During this past year two opportunities were presented for further experimentation in this area. One, the most dramatic, was the involvement of the Webster College Experimental School with a public school (Delmar-Harvard) from University City, Missouri, a nearby newly integrated suburb. The experience involved twelve fourth graders who were disruptive at Delmar-Harvard. They had been diagnosed as both behavior problems and youngsters with learning disabilities. A project was designed to test the effect of a sudden shift in the learning environment. Dr. Pitts directed the program. Advanced students in educational psychology worked on the development of curriculum and the creation of environmental factors. The report on this project involves detailed individual studies of the twelve youngsters and is over 100 pages long. Limited funds kept us from the wide distribution which such a report should have. We produced only enough copies for the administrators who were directly concerned and for the files of the chief investigator.

3. Significant findings and events

See the report of June 30, 1968

4. Dissemination Activities

The major work of the past year has been in this area. The number of requests for materials continues to be great. We have not added to our mailing list the names of those who have requested materials but we have maintained a file of the requests and could up-date our list if we were to resume regular mailings of the WIMSA Newsletter or other publications.

The U.S. Office now has on file with the reports which preceded this Final Report, copies of all of the materials produced under this contract.

5. Capital equipment acquisitions: None

6. Forms: None

7. Other Activities: None

8. Staff summary

Name	Title	Proportion of Time
Jacqueline Grennan	Director	1/5
Charles F. Madden	Research Coordinator	1/2
Sr. Gabriel Mary Hoare	Materials Developer	3/4 for 1 semester
Robert Strobridge	Materials Developer	1/3 for 1 semester 3/4 for 1 semester
Thomas Linehan	Materials Developer	1/2
Jana Patton (Craig)	Materials Developer	3/4
Philip Sultz	Materials Developer	1/6*
Barbara Long	Materials Developer	1/2
Consuelo Wise	Materials Developer	6 weeks (full)
Alice Gatchell	Materials Developer	6 weeks (full)
Fred Stopsky	Materials Developer	1/6*
William McConnell	Materials Developer	1/3
Dr. Mary Lou Prendergast	Materials Developer	1/4
Mrs. Arthur Dixon	Materials Developer	1/4*
Dr. Carl Pitts	Materials Developer	1/2
Helen Eckelkamp	Teacher-Collaborator	1/4
Audrey Alkhas	Teacher-Collaborator	3/4
Sr. Josita De Marea	Teacher-Collaborator	3/4
Mary Ann Salsich	Materials Developer	1/4*
Miriam Meligrito	Materials Developer	1/4*
Frank Ross	Photographer	36 days
Rita DeLisi	Consultant	5 days
Sr. Anna Barbara Brady	Consultant	2 days*
Dr. Robert Sokal	Consultant	1 day
Dr. Jim Stone	Consultant	10 days
Adelaide Whitesitt	Editor and secretary	(full)
Karen Vega	Secretary	(full)

9. Future Activities

As stated in the Interim Report of June 30, 1968 we had submitted a request for continuing support of Project No. 66-1754-1-10. This request was denied. Webster College in a limited way is continuing under its own budget the testing of cross-disciplinary materials in the classroom. We have negotiated for the publication by commercial houses of some materials produced after the contract was terminated and we are continuing the development and production of multi-media materials. Our major task seems to be the training of teachers to handle these new methods of instruction.

---

*Not funded by the Office of Education

10. Certification

Signature of Contract Officer

Jacqueline Brennan
Signature of Project Director

Date

June 13, 1969
Date